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CLIPPERS OF THE CLOUDS

PAN AM'S "ROGUE" ATLANTIC CONSTELLATIONS

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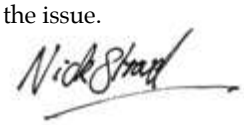
Editor's Letter

A VERY WARM welcome to *TAH35*, in which we take a characteristically varied tour of some of the more unusual nooks and crannies of aviation history. Highlights include Prof Keith Hayward's commentary on the political punch-ups at the heart of government during the start-stop-start procurement of the Hawker Siddeley (later BAe) 146; and Dr Andrew Arthy's minute-by-minute account of the staunch efforts of Luftwaffe fighter unit *Jagdgeschwader 2* to hold the defensive line over the beaches of Dieppe on August 19, 1942. I'm also particularly pleased to present what I am confident is the most complete history of Argentina's IAe.30 Ñancú twin-Merlin-engined fighter published to date, after more than a decade of extensive archive-digging by South American aviation historians Ricardo Lezon and Santiago Rivas. This "homegrown hot-rod" could have been a real contender had it been developed sooner — but it was largely obsolete before construction started, thanks to the advent of the jet engine.

If you like a mental challenge, Matt Bearman's fascinating article on the aerodynamics of propellers, and specifically the effects of supersonic shockwaves thereon, will provide plenty of meat for your brain to chew on. It's interesting that so little attention has been paid to propellers over time; as with aerodynamics generally, historians looking back at the subject tend to put it into the "too difficult" box. Indeed, realising that Matt's article contains some potentially mind-spraining mathematics and concepts that seem bizarrely counter-intuitive — pulling the throttle back to go faster, for example — Managing Editor Mick and I discussed whether it might be *too* technical. But, as Mick rightly says:

"This article really does advance our understanding, which is exactly what we should be aiming for; it very satisfyingly identifies a common thread linking several apparently unrelated aircraft which, although promising, all turned out to be disappointing. That is real aviation-history magic."

I agree — and hope you will too! Enjoy the issue.



FRONT COVER ***A colourised photograph of Lockheed Constellation NC88837, named*** **Clipper,** ***at Burbank before delivery in late 1945. Colour by RICHARD JAMES MOLLOY.*** GREG SMITH COLLECTION

BACK COVER ***Focke-Wulf Fw 190 "Yellow 2 + I" of the 9. Staffel of JG 2 undergoes maintenance in northern France in 1942. Dr Andrew Arthy's analysis of JG 2 at Dieppe starts on page 106.*** MORTEN JESSEN

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AIR CORRESPONDENCE

Letters to the Editor

To war armed with peashooters?

SIR — First, thank you for a hugely interesting magazine. The articles are impressive but so is the readability of what are detailed technical subjects — talented authors and a good editor would be my guess.

Of particular enjoyment were the items on the Hawker Typhoon's structural resonance problem *(Bad Vibrations, TAH27)* and the sleeve-valve Hercules *("The Most Important Bristol Engine of All Time . . .", TAH31).*

The articles about the build-up to World War Two and the assumptions driving it were brilliant and very thought-provoking.

In that vein, I have something that has puzzled me for years and that Greg Baughen's article *1940: The Battle of . . . Kent?* in *TAH32* touched on. Why did we go to war with "pop guns", albeit it with de Wilde incendiary bullets? The article talks about the use of cannon for bomber-destroyers. They fitted Hispano-Suiza cannon to some Spitfires and in most cases (some retained them throughout) they were removed as they kept jamming. I've seen articles blaming the jam on the thin wing and the need to install the cannon at an angle. But why, in that case, not fit them to the bomber-destroyers — the Hurricanes? I gave a talk 30 years ago at the Institute of Engineers on quality standards (bemoaning them) and one of the attendees was an engineer at the Royal Ordnance. He told me that Martin or Baker (I can't remember which now) had picked up an ammunition magazine, shaken it and said, "That's the reason, it doesn't rattle enough" — i.e. the rounds were too tight in the drum.

Also there was seemingly shameful adherence to the 0·303in machine-gun for our bombers. I assume weight was the argument, but why not twin 0·50ins instead of four 0·303ins, as was fitted later in the war?

I would like to think there was enough here for an article — for which you'd have at least one avid reader.

Richard Davis *Forest of Dean*

We will doubtless return to the subject with a full-length article in the future, but for now our armament specialist Mark Russell replies:

Many since 1945 have questioned why the RAF went to war armed with 0·303in machine-guns, instead of the 0·5in guns used by the USAAF and Luftwaffe. However, RAF testing in the inter-war period had determined that the 0·5in gun offered no significant advantages over the 0·303in gun, and would be unlikely to be able to damage armoured aircraft; hence the RAF made the logical decision to stick with the 0·303in gun and also to pursue the 20mm cannon.

So the RAF armed its fighters and bombers with 0·303in guns, with 20mm cannon in the pipeline for fighters (the Westland Whirlwind, for example, had been specified as far back as 1935 with an armament of four 20mm cannon). For fighters, the 20mm cannon began to appear in 1940 and in 1941 became standard armament for fighter aircraft, seeing the RAF's fighters armed on a par with those of the Luftwaffe throughout the war. And the 0·303in gun did win the Battle of Britain, regardless of any supposed shortcomings.

For Bomber Command, it always felt undergunned with the 0·303in after experience in 1939 and the first half of 1940 conclusively showed that it could not operate in daylight protected only by turrets armed with this weapon. However, the USAAF's experience of daylight operations showed that 0·5in guns would not actually have helped; it was the arrival of long-range escort fighters, not 0·5in guns, that made daylight operations feasible. What seems more likely to have made a difference to Bomber Command would have been much better visibility from turrets (which the AOC-in-C, Air Chief Marshal Sir Arthur Harris, at one point described as being "80 per cent angle-iron and 20 per cent scratched Perspex"), to allow bombers to see — and hence evade — nightfighters earlier.

So the RAF's choice of 0·303in machine-guns was sensible, and choosing 0·5in-calibre guns instead seems unlikely to have made a significant difference.

Send readers' letters for publication to: Air Correspondence, The Aviation Historian, PO Box 962, Horsham RH12 9PP, UK, or (preferably) e-mail them to the Managing Editor at mickoakey@theaviationhistorian.com

To colour or not to colour . . .

SIR — I read with interest your *Editor's Letter* in *TAH34* about the colourising of historical photographs and the debate it has created. Graham Simons has a valid point about "faking history", but I think there is more to it. History was in colour; the fact that colour film and cameras came along later is not history's fault.

And if everyone was to be honest about this, don't we all wonder how much better a historic black-and-white photo would look if it had colour in it? Colourising is a representation, nothing more. I think it helps to understand the past more as well.

No doubt many will disagree!

Keep up the good work!

Andy Height *Welney, Norfolk*

D.H.9s in Afghanistan

SIR — Vladimir Kotelnikov's article *The Long Road to Kabul* on Soviet aircraft in Afghanistan in *TAH33* is a good example of what makes *The Aviation Historian* so great: thematic, chronological and geographical diversity, often with a good dose of "off the beaten track"!

I would like to offer a few additions to the article. The aircraft delivered to Kabul in 1924 were in fact four (not six) D.H.9s with Siddeley Puma engines; one of them is shown in the image on page 51. The Soviet Union had just taken delivery of 42 such aircraft from Great Britain in 1923 and 1924 and it was surely four of those that were resold to Afghanistan. The delivery of R-1s (D.H.9A copies) in 1928 is trickier to sort out, but Great Britain had intelligence officers posted in Kabul, who often reported in detail about aviation matters.

The first report clearly related to R-1 deliveries noted the arrival in Kabul of nine R-1s from Termez in the Soviet Union on May 13, plus one that landed at Parachinar, near the border to India, that was damaged and had to be left there. A tenth machine landed near Jalalabad, east of Kabul, and arrived in Kabul on the following day. Three more R-1s were expected, and they reached Kabul on June 1. That amounts to 13 aircraft; but in addition to this, three aircraft had arrived "on the aerial line" from Termez to Kabul on April 13. With these the total amounts to 16. One R-1 (of those acquired in 1925, presumably) that had been sent from Kabul to act as a guide for the delivery pilots had an accident at Termez and one Russian and one Afghan were killed when it caught fire.

Of interest is also that the Afghan government tried to obtain Grigorovich I-2bis fighters and placed an order for eight on December 22, 1927. These aircraft were being completed for delivery in August 1928 and a group of Russian pilots prepared themselves for service in Afghanistan. Delivery was delayed owing to technical deficiencies and difficulties with the planning of a delivery flight with single-seat aircraft over rugged territory, and in May 1929 an order was issued that called for the transfer of these aircraft to the Soviet Air Force instead.

Lennart Andersson *Uppsala, Sweden*

LATI shenanigans

SIR — I read with interest the series *Italy's Forgotten Airlines (TAH31–33),* and in particular the section on early transatlantic flights in *TAH32's* article. LATI has been a subject of special interest to me, because of the role it played in early World War Two Axis intelligence operations. That fits into my research on the

BELOW ***Positively bristling: Westland Whirlwind P6984 of No 263 Sqn shows off its four nose-mounted 20mm cannon. Why were more RAF types not similarly armed? See Richard Davis's letter on the opposite page, followed by Mark Russell's response.*** PHILIP JARRETT COLLECTION

subject of World War Two around the (Dutch) Caribbean islands.

The article mentions LATI's transportation of mail and freight, including "precious stones". There is quite a bit more to be said about this. In the final period, 1941, the payload capacity of LATI was almost completely hired by Germany's *Abwehr* foreign intel agency. The precious stones were mostly diamonds confiscated from Jewish diamond traders who were deported and finally killed in the extermination camps. The diamonds were sold on South American markets, and also in the USA, and the proceeds were used to finance fascist and Nazi supporters and the Abwehr agents in the Western Hemisphere.

The British were very much aware of what went on with the LATI transatlantic operations and tried everything to get the Brazilian government to stop them. They also tried to get the still "neutral" USA to stop Esso from supplying 100-octane aviation fuel to LATI in Brazil. This fuel came from the Esso Lago refinery at Aruba, but the Rockefeller family was not inclined to halt their "free enterprise" oil business in that direction. (Nor were they stopping the supply of diesel fuel at Aruba to Spanish tankers, which were routed to the "neutral" Spanish Canary Islands, where it was used to refuel German U-boats. This created the interesting situation that Allied Dutch cargo ships on the Atlantic were torpedoed by U-boats that ran on diesel fuel supplied from the Dutch island of Aruba. "Business is business!" All this is well documented, also in German sources).

The LATI operation was finally stopped early in 1942 through a clever secret operation by William Stevenson of "Intrepid" fame. A forged letter was produced, supposedly written by a Director of LATI in Italy to the company's local Brazilian agent, which contained very serious accusations and insults directed at the Brazilian President. This fake letter was leaked into Brazilian circles with great effect. "Fake News" *avant la lettre,* and it worked. The Brazilians finally stopped LATI.

Gerard Casius *IJsselmuiden, The Netherlands*

Tales of 'LOVE and 'LUCK

SIR — I have enjoyed reading *Italy's Forgotten Airlines* in *TAH31–33* and have one comment on the final part in *TAH33*, regarding page 69 and the back cover. There was also a typo in a caption: LAI's first purchase was for DC-6s, not DC-6Bs, the latter being somewhat later.

There were actually two DC-6s bearing the registration I-LOVE. As LAI came in rather late with its order, it leased two examples from the Argentine Airline FAMA (later Aerolineas Argentinas) and gave them the same two registrations as the first two in their order, namely I-LADY and I-LOVE. The first DC-6s with these registrations flew from March/April to September 1950 for LAI, mainly on the New York route, with LAI's own DC-6s with the same two registrations being delivered in September/October 1950.

You have mentioned to me in correspondence on this matter that the John Stroud picture on page 69 was "probably taken in Rome, and marked as 'DC-6 I-LOVE and I-LUCK of LAI', date unknown" — so it must be of the actual LAI aircraft, rather than the leased aircraft, as I-LUCK was the first of LAI's order to be delivered. John Stroud visited Rome with BEA in January 1951 (from his logbook which we borrowed at the Croydon Airport archives), so it is likely that he took the photo on that occasion. He was there again in August 1951 — it is amazing the number of inaugurals and special flights he managed to get on! Yes, it is frustrating to have such excellent photos undated.

Peter J. Marson *Croydon, Surrey*

Westminster sunset

INSPIRED BY Peter Davison's regular* Off The Beaten Track *features in* TAH, *Tunbridge Wells-based subscriber Richard Waller sent in this poor but rare image — possibly the last photographically-recorded sighting of the two Westland Westminster helicopter prototypes (the tail of the second is just behind the nose of G-APLE), stored at Westland's Yeovilton works prior to scrapping. Richard says, "The photo was taken on May 3, 1963, on my very poor camera and the location would now be just past the guard entrance to RNAS Yeovilton. There may be other photos of this, but if not, anyone studying the helicopter might be interested in seeing this last shot".

Douglas DC-6s I-LOVE and I-LUCK of LAI (Linee Aeree Italiane) at Rome, most likely in January 1951 — with a Lockheed Constellation just sneaking in at stage right. Peter Marson has provided clarification — see his letter on the facing page.

Propeller parallels

SIR — In response to Philip Jarrett's letter in *Air Correspondence* in *TAH34*, about possible connections between Cyrnos and RIP propellers: the person you are interested in is Raymond-Isidore Petit, who appears to have survived World War One unscathed. He lived in the *département* of the Seine (Paris numbers 92/93/94), maybe 31 rue de Flandres. He may have been a mechanic-draughtsman, and in 1902 married one Mademoiselle Lucie Augustine Pauline Petit, a schoolteacher in Strasbourg. Raymond-Isidore is an unusual first name and I suppose he was keen to use his initials to name his propeller "RIP", an acronym with connotations of death. So the only piece of info I found in the period press is the reference to the wedding of Monsieur Petit to Mademoiselle Petit! And he does not appear among the soldiers killed during the Great War.

On December 30, 1909, Petit patented a "propelling screw" *(hélice propulsive).* The documentation describing its principles says, "The invention relates to a propelling screw, mostly applicable to aerial production, characterised by a very marked reduction of the pitch from periphery to the centre. The pitch near the base of the blade must be at most the quarter of the pitch at the circumference. The rear face of the device could be an helicoidal surface or could display a curvature of circular, elliptical or paraboloid layout. The outer shape of the device should be such that the blades have at least the same width as the hub. This screw could be made out of wood, steel, aluminium or any appropriate material."

I can't find any more material about him.

Jean-Christophe Carbonel *Montreuil, France*

[This is very useful additional information, but still does not address the question of whether there was indeed any connection between Raymond Petit and Antoine Filippi, the inventor of the Cyrnos propeller. Any further comments will be welcome! — Ed.]

Thrust reversal?

SIR — I write following the story of Rolls-Royce's RB.211 saga *(Collapse of an Icon, TAH34)* and the firm's eventual survival/rescue, and further prompted by the Pratt & Whitney fan-disintegration media reports in February 2021.

These reminded me of a story I was told not long ago by a friend, who was a de Havilland apprentice in the same intake as me, 1957, who later worked for Britten-Norman and then Rolls-Royce. With R-R he was based in Tokyo in the late 1980s to sell RB.211 engines to the Japanese airlines, specifically for the Boeing 747-400.

He recalled a tale from some years earlier about the first example of an RB.211 front-fan separation, on the "middle" engine on a Lockheed TriStar. The fan "migrated" up the "S" duct before chewing down into the fuselage, coming to rest in the rear "toilet block".

This was apparently a very memorable experience for everyone in the company, as being the first time that "the fan had hit the s**t"!

Richard Seth-Smith *London NW7*

The Stop & Go Show

The Hawker Siddeley 146 saga, 1973–78

By the early 1970s the Hatfield division of the Hawker Siddeley Group was ready to explore the viability of a civil jet airliner — enter the HS 146. **Prof KEITH HAYWARD FRAeS** describes the genesis and evolution of the type's start-stop-start development programme, in which the irresistible force of Tony Benn met the immovable Denis Healey…

TAH ARCHIVE x 2

THE HAWKER SIDDELEY — later British Aerospace (BAe) — 146 was the last example of a tradition of de Havilland Hatfield jet airliner designs stretching back to the D.H.106 Comet. The decisions surrounding the launch of the 146 in the early 1970s were somewhat overshadowed by the 1971 bankruptcy of Rolls-Royce (see *Collapse of an Icon* in *TAH34*), the ongoing huge costs of Concorde and the complex politics of the Airbus and British-designed competitors (see *Airbus Industrie* in *TAH28*). However, the 146's start-stop-start history reveals much about the complicated politics of UK aerospace in the 1970s, culminating in the formation of BAe in 1977. It was also affected by an intense triangular personal and political contest between two members of the 1973 Labour government and the head of Hawker Siddeley.

Launching the 146

For much of the 1960s, as part of the Hawker Siddeley Group (HSG), the Hatfield design team focused on wings for the European Airbus project. By the end of the decade there was time to consider a smaller independent project. By 1971 preliminary work suggested that a high-wing jet feederliner with four Avco-Lycoming ALF 502 turbofan engines had promise. Although prospective development costs — £90m — were relatively modest, some element of government support would be welcome. Accordingly, in 1973 Hawker Siddeley submitted a request to the Department of Trade and Industry (DTI) for launch aid (subsidisation from the government in return for a share of future profits) to cover 50 per cent of the total development costs. As DTI officials noted, Hawker Siddeley could have raised the money, but "sought government participation in order to maintain better balance over the Group's diversified activities".[1]

In light of Rolls-Royce's bankruptcy, announced in February 1971, the application was carefully examined by the DTI and was discussed at some length in Cabinet. As a minister later put it, the aim was to ensure that "the prudent industrialist cannot unwittingly blunder into a situation in which he finds he has put himself at risk".[2] The government was impressed by the company's confidence in the concept, designated 146, and asserted that it was "a crucial project for keeping the British aircraft construction industry alive" and sustaining the Hawker Siddeley design team — "the elite of the industry".

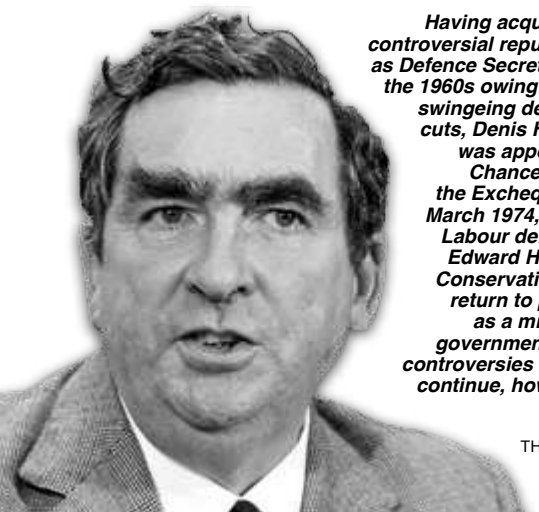
Treasury ministers were less sure; as a national programme it would do little to promote European integration or domestic rationalisation — key concerns of the Conservative government of Edward Heath. But the clinching argument was that rejection would "undermine the new strategy for the aircraft industry" and "signal major doubts about our determination

ABOVE ***The wooden mock-up of the Hawker Siddeley 146 at Hatfield in 1974, comprising a complete fuselage, wing with engine nacelles and fully instrumented cockpit. The fuselage was designed to accommodate five Boeing 747 seats abreast, with two variants, the Series 100 (up to 88 passengers) and Series 200 (up to 112), to be developed.***

LEFT ***Sir Arnold Hall joined the Hawker Siddeley Group as Technical Director in 1955, having formerly been the Director of the Royal Aircraft Establishment from 1951. Hall was appointed Managing Director of HSG in 1963 and Chairman four years later. Openly hostile to nationalisation, Hall left the industry upon the formation of BAe in 1977.***

to maintain a civil aircraft industry in the UK".[3]

Nevertheless, the Treasury pressed for a detailed study of alternatives, including an emerging all-European option, an approach that would be more consistent with the government's application to join the European Economic Community (EEC). Embarrassingly, the 146 would also compete with the Dutch Fokker F-28, which had Rolls-Royce engines and Belfast-made wings.[4] The Foreign Secretary, Sir Alec Douglas-Home, thought that the European problem could be finessed: "The UK has not (unlike other European countries) launched a civil aircraft for more than ten years". He continued: "A prerequisite for the establishment of a strong European industry is a healthy British industry with an adequate volume of commercially sound work. Moreover, I see no reason why the HS 146 should prejudice the opportunities for co-operation on the next major project for the European aircraft industry."[5]



Having acquired a controversial reputation as Defence Secretary in the 1960s owing to his swingeing defence cuts, Denis Healey was appointed Chancellor of the Exchequer in March 1974, when Labour defeated Edward Heath's Conservatives to return to power as a minority government. The controversies would continue, however.

The government was under pressure from Sir Arnold Hall, Hawker Siddeley's fearsome Chairman, who wanted a quick decision. He was backed by the DTI, which opined that "Hawker Siddeley are an enterprising and successful firm who would not commit themselves to a project for which they did not foresee a reasonable return; and their willingness to bear any cost over-runs certainly shows their confidence in the project".

Hawker Siddeley's case was strengthened by a positive report on its overall financial position and the likely market for the aircraft, which would provide a solid return on the government's money. The Treasury, however, still felt that Hawker Siddeley was duping the DTI: "As we feared, [the] DTI [is] losing out to Hawker [sic] all along the line". Crucially, in the light of later events, there was an exchange of letters between the DTI and Hawker Siddeley discussing the grounds under which either side could terminate the agreement, which included "substantial doubts" about its market prospects.[6]

The green light...

In April 1973 the DTI submitted a formal request to approve the 146 launch-aid application under terms "more favourable than the government had obtained in any previous agreement on launching aid". Moreover, "Hawker Siddeley [was] the most capable British firm in this field; [it] had a strong management and enjoyed a consistent record of fulfilling [its] contracts and observing [its] prices. If support for this project was refused, however, there was a real risk that the company would largely withdraw from the aircraft industry". In respect of any objection from Brussels, these were to be dismissed, as the support package for the 146 "was a model of the sort of government participation that the Commission should wish to encourage rather than hinder".[7]

The DTI was confident that the 146 was a sound and viable project; indeed, sales were estimated to be worth £300m by 1985. Moreover, it would show confidence in Hawker Siddeley, the managerial abilities of which were "of the first importance for the successful reorganisation of the British aircraft industry".[8]

The DTI won its case, and in the formal launch-aid agreement the government undertook to invest £40m at 1972 prices, with some adjustment for inflation, which covered half of the expected launch costs. Announcing the decision in August 1973, Michael Heseltine, Minister of State for Aerospace & Shipping, stated that the firm

TAH ARCHIVE

RIGHT ***After much deliberation and inter-governmental wrangling, the HS 146 was suspended in late 1974 in the wake of a global economic depression brought on by a crisis in oil prices. Little more work was undertaken on the project until it became a flagship development programme for the newly nationalised BAe, which issued this artist's impression in 1980.***

would take responsibility for any rise in costs, and as such it would be a genuine risk-sharing arrangement. More importantly, it was "the first major new aircraft launched in this country for more than a decade, and will help to maintain UK position in European industry as whole."[9]

Within months, however, events led Hawker Siddeley to re-examine its commercial judgment and look to terminate the 146 — a decision that would lead to a confrontation with a new Labour government, or at least its militant Secretary of State for Industry, Tony Benn.

. . . turns amber . . .

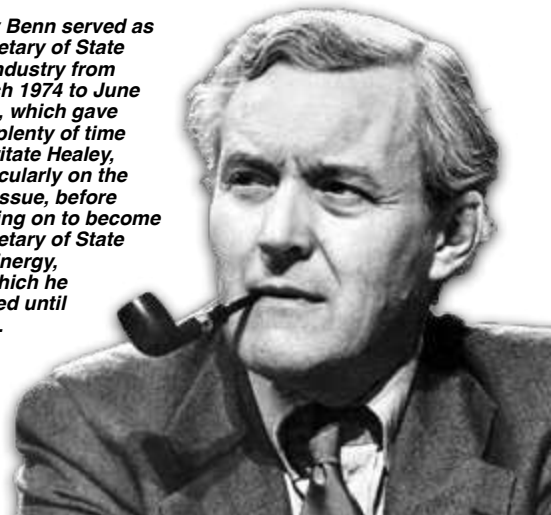
The launch of the 146 in the latter part of 1973 coincided with a severe downturn in the world economy, triggered by a huge increase in the price of oil. Air traffic slumped and inflation began to render any long-term financial forecast highly risky. Hawker Siddeley's campaign to sell its new airliner was hit hard. More domestic political uncertainty came in February 1974 with the election of a Labour government determined to nationalise the aerospace industry.[10]

In July 1974, just as the nationalisation process was beginning, Hawker Siddeley informed the DTI that it intended to halt the 146 programme on commercial grounds. A wider political motive immediately occurred to officials: "[Hawker Siddeley] deny that they are influenced by the prospect of being nationalised, but since most of the working capital required by [their] share of development is coming from the funds of the Group generally, HSG could well have decided that they can find better uses for their money outside the aircraft industry". The Treasury felt that Hawker Siddeley should be allowed to make up its own mind about the 146. Initially, so did the DTI: "Hawker Siddeley should be allowed to drop the project as a mutually agreed termination".[11] This was a crucial point; if the company dropped the project unilaterally, it would have to pay the whole cost of cancellation.[12]

The Treasury believed that HSG had a good case for an agreed termination of the contract. The company's view of the market was uncontested — repaying the government's investment depended on an unrealistic number of sales: "In these circumstances the DTI would be hard put to deploy honest arguments for continuing with the project". It was in everybody's interest to secure a clean break "as quickly as possible". Consequently, DTI officials advised the Treasury to recommend cancellation to the Chancellor of the Exchequer; a view endorsed by the latter, Denis Healey.[13]

The prospect of nationalisation and the likely level of compensation that HSG might receive affected the latter's position. The company proposed either a mutual termination of the agreement or a radical renegotiation of the launch-aid contract, reflecting higher development costs of more than £90m, perhaps rising to £200m.[14]

Benn opposed termination and his response to Hawker Siddeley was swift; writing to Sir Arnold Hall he claimed that, as the programme was proceeding well technically and that sales forecasts were still promising, the risk of failure was only "conjecture". More importantly, "the 146 is the only substantial new civil project now in process of development in the British aircraft industry. Clearly no government could view its cancellation without serious concern if this country is to remain a leading aircraft manufac-



Tony Benn served as Secretary of State for Industry from March 1974 to June 1975, which gave him plenty of time to irritate Healey, particularly on the 146 issue, before moving on to become Secretary of State for Energy, as which he served until 1979.

TAH ARCHIVE

ABOVE ***Production of the 146 finally got moving at Hatfield after the formation of BAe in 1977, this press photo showing the first examples well progressed in mid-1980. Bob Grigg's design had simplicity of operation and economy at its heart, the airframe and systems incorporating as many "off the shelf" components as possible.***

turer in the future to meet a world market, which, whatever its short-term difficulties, is likely to continue to grow. It would necessarily raise questions of the national interest. The company should also consult the unions on this matter."[15]

Benn wrote to Prime Minister Harold Wilson, stating that Sir Arnold's arguments focused on "gloomy expectations of world economic growth, inflation and airline finances". He also suspected ulterior motives: "Hawkers' [sic] proposal is to a considerable extent caused by extraneous factors relating to the Group as a whole, and by their attitude towards nationalisation". He repeated his view that the aircraft had a wider significance to the future health of the industry, "which cannot be treated cursorily in the manner proposed by Hawker Siddeley".[16]

At a meeting with Hall in August 1974, Benn told him: "I do not like the reasons Hawker Siddeley give for cancelling this project". He challenged Sir Arnold's inflation assumptions: "It is not easy to see why HS insisted on this, as UK costs only accounted for 40 per cent of the total, although undoubtedly, increased British inflation would impinge on the company's margins in a highly competitive field". Benn, pushing hard the government's commitment to industrial democracy, was also incensed that HSG had failed to consult the unions. Sir Arnold had no objections if Benn did so, but any discussions with the unions could have "no role on the narrow question of whether it is proper to terminate mutually under the terms of the contract".[17]

A meeting with the unions later in the summer stiffened Benn's resolve. Writing to Sir Arnold in September, he stated: "I have met union representatives and I must tell you frankly that the government [is] not at present convinced by your arguments that continued expenditure under the contract is no longer justified".[18] For his part, Sir Arnold was convinced that the DTI could not legally block a valid commercial decision without providing full financial backing; as Hall recalled in the 1980s, "I would have relished our day in court".[19]

...to red

Sir Arnold's position received strong backing from the Treasury, especially from Chancellor Healey, whose personal feud with Benn was already poisonous. A Treasury note to the DTI in October was quite blunt: "The Treasury must be consulted on any reply to Hawker Siddeley". The Chancellor was concerned about the state of government spending, arguing that "nothing should be done that might frustrate the cancellation of the project". Healey followed this up with a letter to Benn, copied to Wilson: "As you know, it seems to me that the right course is to have it terminated before we come to the nationalisation of the industry, and nothing should be done which would run counter to this objective. It seems to me that the clear corollary of this is that we should acquiesce in the company's proposal to cancel the project". In particular, Healey was anxious that Benn should not give the impression of any further aid to the company: "I am sure that you will not wish to create any

TAH ARCHIVE

ABOVE ***Owing to its quiet ALF 502 turbofan engines, the 146 was promoted as the "Whisperjet". The first three examples were given fitting registrations: the first, G-SSSH, made the type's maiden flight on September 3, 1981 at Hatfield; the second, G-SSHH (seen here) flew on January 25, 1982, and the third, G-SSCH, on April 2 that year.***

expectation that the government would consider taking over the financing of the development of this aircraft, which is estimated to require something over £100m, not taking account of future cost inflation".[20]

The Treasury believed that the company had acted "reasonably" in halting the 146 programme before too much was committed to a project that was not technologically vital to the industry. While Benn might argue continuation on industrial grounds, "a non-viable project would be a very poor start for the proposed nationalised industry". In general, the Treasury note continues, "it will be unfortunate if we have to face the combined 'loaded' opposition of Messrs Benn and [Michael] Foot [Secretary of State for Employment]. The estimate of 10,000 jobs at risk was based on the original production programme, which cannot now be achieved. Pulling out now, the effect on jobs will be limited and [will invoke] minimum nugatory expenditure".[21]

This did not stop Benn from responding sharply to a Hawker Siddeley press statement confirming cancellation: "I have to inform you that the Secretary of State is not convinced that such a termination under this clause is justified. Moreover, the Secretary of State does not accept that your company is entitled to expect his agreement to such a course in the manner you propose". Writing directly to Sir Arnold, Benn states: "I cannot agree, as requested in your letter of 14th October, to accept termination of the HS 146. I wrote to you suggesting a course of action and offering further discussion. You have not taken up my offer. I have now arranged urgently to meet with the trade unions concerned to discuss the issue. You or your representatives are welcome to participate".[22]

Hairs start bristling

On October 25, 1974, Benn wrote to Healey, blaming Hawker Siddeley for the worsening commercial position, as well as disputing the Treasury target of a ten per cent return on public investments and its "arbitrary application" of comparative exchange and inflation rates. He pointed to a prospective 400 sales that would bring in £450m in exchange earnings. If Treasury rules were applied universally, "there would be few, if any, industrial projects in the UK that could be judged viable". The government had to be prepared to take actions to "defend industry capabilities, especially on the civil side and to accelerate nationalisation".[23]

Benn was careful not to push his luck with Healey, however: "Your interventions today have surprised me. You accepted the Cabinet Economic Committee view that in the event of HS cancellation, there should be time for further discussions and consultations [with the unions]. I have no intention of offering any government money to Sir Arnold Hall to finance this project without seeking explicit authority to do so".[24]

Despite these assurances, Benn's motives were suspect, as a note from the Cabinet Office to Wilson observed:

"You have seen the exchanges. There is no reason to get involved. The Chancellor is

MIKE HOOKS

ABOVE ***The 146 prototype, G-SSSH, at Hatfield in July 1982. The first three aircraft were painted in a rather stylish promotional four-tone colour scheme, the first and third in warm yellow and orange bands thickening aftwards over a white fuselage and a dark belly; the second, G-SSHH, in the same scheme but in a cooler blue palette.***

suspicious of the Secretary of State's objectives here. But he believes that his stance is the best protection of public money as long as it does not entail the government coming under irresistible pressure to take over the financing of this aircraft against its better judgment. Mr Benn should not give the unions grounds at this stage for hoping that development of the aircraft will continue. The impression which is given to the unions is not easy to control, but at least Mr Benn now knows that the hairs on the backs of the Treasury watchdogs are bristling."[25]

The Treasury did indeed distrust Benn's motives: "The Chancellor asked this morning whether we could safely assume that Mr Benn would not seek to keep the HS 146 in being. I said that this would not be a safe assumption". The Treasury was, however, relieved to note that Benn would not "mention money". The Treasury suggested that officials "should ask Mr Benn's office to clear all letters or statements in advance. Otherwise I do not know how to arrest a Concorde-type train of events. Obviously the Chancellor will not want to start the new Parliament with a dispute with Mr Benn but, since the Chancellor is opposed to the project, I do not see how we can advise otherwise than above".[26]

A reprieve?

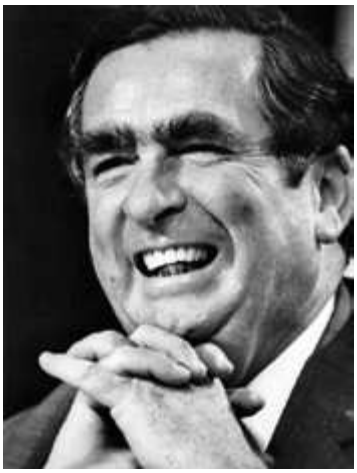
In November 1974 Benn considered how the government might "keep the programme alive". He outlined three options: continuation with 100 per cent support; buy two prototypes with 100 per cent support, or defer the programme for two to three years to allow the future nationalised company to assess its viability. He concluded:

"The arguments are finely balanced. However, I believe it is vital that we should demonstrate our support for the future of the civil aircraft industry by being ready for the market for this type of aircraft, which will surely come. This will maintain vital productive capacity in an industry where we have special skills. If we do not act now the competition could well take our place."[27]

In a joint assessment, the DTI and Department of Employment concluded that, while the aircraft's short-term market prospects were poor, further out the outlook appeared better. Deferment was feasible; it would cost £2m–£3m over two to three years, and the company was prepared to retain the jigs and other production facilities. However, restarting might be more difficult for sub-contractors and could be more expensive if there was a substantial gap between the deferment and a restart. Lycoming, for instance, was in a difficult financial position and its powerplants might not be available in the future.[28]

The Treasury remained sceptical, however: "Of the 'may well prove to be a winner' argument, there [are] simply no grounds for such optimism. Uncertainty abounds and the future could be even worse". The foreign exchange argument was undermined by the fact that half of the aircraft's components were of overseas origin. Overall, the arguments were a poor justification for spending £100m on an uneconomical project. On the other hand, as Hawker Siddeley was prepared to maintain a civil design capability, deferment would provide an opportunity to review the project at a later date, and to cancel the aircraft if its commercial prospects were poor.[29] But as the government geared up for what was becoming a hard struggle to deliver nationalisation, the Treasury's hard-line position was increasingly difficult to sustain.[30]

In December 1974 the decision went to full Cabinet. Healey wanted to limit the government's obligations to Hawker Siddeley, but he was now prepared to accept "suspension" of the programme pending nationalisation and a future review when "economic and commercial conditions were more certain". The Cabinet accepted that "on balance,



ABOVE LEFT ***During his tenure as Industry Secretary, Tony Benn fought hard to keep the 146 project alive, but ultimately had to accept the decision to mothball it, made by Denis Healey*** **(ABOVE CENTRE). ABOVE RIGHT** ***Sir Frederick Page, formerly with BAC, was appointed BAe's first Chairman on the industry's nationalisation in 1977.***

the right thing to do was to keep the project in cold storage for two or three years, at a cost of £2m–£3m". Future decisions would be left to the nationalised BAe. Hawker Siddeley agreed to pay its subcontractors some £10m in compensation and the £4m in launch aid would be included in company valuations in respect of nationalisation. The 146 was duly mothballed.[31]

Nationalisation and relaunch

The nationalisation process was a protracted exercise, delayed by procedural complications. Although Benn was replaced as Secretary of State for Industry in June 1975 by the less militant Eric Varley, the government remained convinced that a publically owned aerospace industry was the only way forward, especially if the UK was to remain a force in the civil market.[32] But as a nationalised enterprise, BAe ceased to be eligible for launch aid, and would have to obtain government approval for its business plan and appropriate capitalisation. If it wanted to relaunch the 146, BAe would have to fund it from within its own resources. According to Sir Freddie Page, the first head of BAe's Aircraft Division, this was one of the "most difficult decisions facing the new management". Market forecasts were good, but there were already a number of "entrenched competitors" in the 100-seat jetliner market.

The Board agreed that the case for relaunching the 146 was reasonable, especially as, by 1978, its market prospects had improved. Inflation rates had eased, making cost estimation less uncertain. Nevertheless, a full-scale development programme was still needed. As Page recalled: "The financial viability of this project was marginal, and even if strictly controlled they would have to live with it long after I retired".[33] However, the Board was conscious of the need to maintain employment across a range of sites, and there was some pressure to launch a "flagship" project under the BAe badge. As Chairman, and with close contacts with the Labour government, Frank Beswick was especially sensitive to the employment question and faced strong pressure from Hatfield to relaunch the 146. The BAe Board finally accepted these arguments and, with DTI agreement, £250m could be released

In a revised promotional colour scheme, the first 146-200, G-BMYE (originally G-WISC for its maiden flight on August 1, 1982), comes in to land after displaying at the SBAC show at Farnborough in September 1986. Note the distinctive open air brake at the tail. The 146-200 was "stretched" by 7ft 11in (2·4m), allowing a maximum of 112 passengers in rows of six abreast.

MIKE HOOKS

1 Hayward, K., *Government and British Civil Aerospace*, Manchester University Press, 1983, pp188–190
2 Cranley Onslow, Under Secretary of State, DTI, Hansard Vol 850, February 12, 1973, col 1247
3 Paper to Ministerial Committee on Economic Policy (Chaired by Secretary of State for Scotland), March 23, 1973, UK National Archives (TNA) ref PREM 15/1291; Treasury Memorandum, March 20, 1973, TNA ref T225/4318; Ministerial Committee for Economic Policy Item 1, February 26, 1973, and Memorandum 6, February 16, 1973, from Secretary of State for Industry, TNA ref CAB 134/3598
4 Treasury memorandum, March 6, 1973, TNA ref T225/4318
5 Telegram to Dutch Foreign Minister, May 18, 1973, TNA ref T225/3889
6 Exchange of letters between DTI and Hawker Siddeley (HS), February 1973, TNA ref T225/3889. While Hall was Chairman of Hawker Siddeley Aviation (HSA), the key commercial and technical decisions were taken by a team led by the Managing Director, John Lidbury
7 TNA ref CAB 128/52/1, April 12, 1973; minutes of EC Commission meeting,March 28, 1974, TNA ref T225/4320; telegrams from UKREP Brussels, August 1973, TNA ref T225/4319
8 Ibid. The government was encouraging a merger of BAC and HSA
9 Hansard, Vol 861, October 22, 1973, cols 687–688
10 Hayward, K., op cit, pp193–195
11 Treasury note of meeting with DTI, July 10, 1974, TNA ref T225/4320
12 My thanks to David Morden for this observation
13 Treasury Memorandum, July 18, 1974, TNA ref T225/4320
14 Hall's bearish position may have accelerated nationalisation: "Because of the fuss created by the decision of HSA to end the HS 146, the Secretary of State now wants to press ahead with nationalisation with the utmost speed". Treasury memorandum, October 28, 1974, TNA ref T225/4107
15 Letter to Sir Arnold Hall from Secretary of State for Industry, July 23, 1974, TNA ref PREM 16/741
16 Letter from Secretary of State for Industry to Prime Minister, August 5, 1974, PREM 16/741
17 Note of meeting between Tony Benn and Sir Arnold Hall, August 1, 1974, TNA ref T225/4320; note of meeting with HSA and DTI, August 30, 1974, TNA ref T225/4320
18 Letter to Sir Arnold Hall from Secretary of State for Industry, September 12, 1974, TNA ref PREM 16/741
19 Interview cited in Hayward, K., op cit, p192
20 Treasury note to DTI, October 16, 1974, and letter from Chancellor to Secretary of State for Industry (copied to Prime Minister), October 17, 1974, TNA ref PREM 16/741
21 Treasury notes August 7 and 21, 1974, TNA ref T225/4320
22 Letter to HSA from DTI, October 16, 1974, and letter to Sir Arnold Hall from Secretary of State for Industry, October 15, 1974, TNA ref PREM 16/741
23 Letter from Benn to Healey, October 25, 1974, TNA ref T225/4097
24 Letter from Secretary of State for Industry to Chancellor of the Exchequer, October 17, 1974, PREM 16/741
25 Note to Prime Minister from Cabinet Office, October 18, 1974, TNA ref PREM 16/741
26 Treasury PPS note, October 16, 1974, TNA ref T225/4097
27 Paper from Benn, November 19, 1974, TNA ref T225/4097
28 Note from Departments of Employment, Trade & Industry, Treasury and Ministry of Defence, *HS146 Aircraft*, November 1974, TNA ref T225/4097
29 Memorandum, November 22, 1974, TNA ref T225/4098
30 Treasury note, November 21, 1974, TNA ref T225/4098
31 Cabinet minutes, December 5, 1974, TNA ref CAB/128/55/25. Nationalisation was completed in April 1977
32 Hansard, Vol 901, December 2, 1975, cols 1445–1446. Benn went to the Energy Department. This was seen as a demotion, but he had annoyed his colleagues and the Prime Minister too often
33 Hayward, K., *Freddie Page: Aerospace Engineer and Businessman*, Royal Aeronautical Society Paper, 2010. I am also grateful to David Morden for his comments about Page's appraisal of the 146
34 Ibid. I am also grateful to David Morden and Bill King for their comments on the BAe board deliberations
35 The ATP, a development of the HS 748, was the other regional aircraft launched by BAe. I am grateful to Richard Aboulifa for reminding me of this issue

for full development, with additional investment available if required from the National Loan Fund. The 146 was up and running again.[34]

The long view

Tony Benn had manœuvred the Treasury and its Chancellor into accepting deferment as the least-worst of several unpalatable options. Cancellation, with the government struggling to nationalise the industry, would have been embarrassing. Continuing with the project in the face of the company's commercial judgment threatened other economic and political costs. The decision to leave the decision to the newly nationalised BAe was a "middle way".

Was the relaunch justifiable? The BAe 146 made a good start, benefiting from American demand for "feederliners"; its exceptionally quiet engines were also a useful selling point. But Page's scepticism proved justified in the long-term. With a total of 394 sales (including later Avro RJ development at Woodford), the 146 had some success, but overall it proved something of a drain on BAe resources. Regional aircraft generally proved to be a loss-making exercise; in the 1990s BAe's exposure to 146 leasing almost bankrupted the company.[35] The main lesson to be learned from the 146 story was that international collaboration remained the most realistic option for UK civil aerospace.

ROVER DAVID

CLOSE AIR SUPPORT IN THE SECOND WORLD WAR – PART TWO

Based on research for the forthcoming second volume of his *Close Call* series of books for Hikoki, **VIC FLINTHAM** concludes his two-part series on the evolution of the Allies' *Rover* system of air support for ground troops in the Mediterranean, this time focusing on the system's refinement as Allied forces fought a bitter struggle northwards through Italy

AT THE TIME of the Battle of the Sangro River during November–December 1943, there was no dedicated Allied fighter-bomber type, nor was fighter-bombing or dive-bombing taught. It was very much for the squadrons and Wings to develop their own approaches. The first type to act as a fighter and bomber in any meaningful way was the RAF's Curtiss Kittyhawk, eventually adapted to carry up to 2,000lb of bombs and with six 0·50in guns. The fighter-bombers were all developed from fighter types, adapted to carry bombs and later rocket projectiles (RPs) and napalm. Bombing in level flight with no bombsight produced poor results, so the aircraft made their attacks in the dive from around 8,000ft (2,400m), which determined the height at which "cab-ranks" (i.e. standing patrols) operated. Guns were routinely fired during the dive and if the target was a gun emplacement this would keep heads down.

KITTYHAWK DIVE-BOMBING

The approach to dive-bombing was described by a pilot of No 112 Sqn, in this case just preceding the introduction of the cab-rank and before it became common practice to fire in the dive:

"The formation to be flown was 12 'Kittys' in two boxes of six, with the second box flying a few hundred feet above, behind and slightly to one side of the first six, preferably between them and the sun. Dive-bombing was from about 6,000–8,000ft [1,800–2,400m] down to 1,000ft [300m]. The target was approached until it disappeared under the centre of the port wing, count to three and then go into a dive down to the left until the target was in front of the aircraft nose. At

ABOVE RIGHT *A* **Rover** *controller on the front line calls in a "cab-rank" of fighter-bombers.* **BELOW** *The Curtiss Kittyhawks of No 239 Wing were of critical importance in the Sangro battle. The aircraft were further adapted to carry three 500lb bombs. This Kittyhawk III, FL726, was operated by No 450 Sqn RAAF.*

AUTHOR'S COLLECTION x 2

THE RAF'S DESERT AIR FORCE AS ON NOVEMBER 10, 1943

Unit	Aircraft type	Base
Desert Air Force (Lucerea)		
No 651 Sqn (V Corps)	Auster III	Vasto, Termoli, San Felice
No 285 Wing RAF (Reconnaissance)		
No 682 Sqn	Spitfire PR.XI	Foggia No 1 (Celone)
No 225 Sqn, B Flight (Tac/R)	Spitfire VB, VC	Foggia No 1 (Celone)
No 40 Sqn South African Air Force (Tac/R)	Spitfire IX	Foggia No 1 (Celone)
No 244 Wing RAF (Fighter)		
Nos 92, 145, 601 Sqns		
No 417 Sqn Royal Canadian Air Force	Spitfire VIII	Foggia-Triolo
No 7 Wing SAAF (Fighter)		
No 1 Sqn SAAF	Spitfire VIII	Palata
No 2 Sqn SAAF	Spitfire VC	Palata
No 4 Sqn SAAF	Spitfire VB	Trigno
No 322 Wing RAF (Fighter) under Coastal Air Force control		
Nos 154, 232, 242 Sqns	Spitfire VB, VC, IX	Gioia del Colle
No 243 Sqn	Spitfire VB, VC, IX	Capodichino
No 239 Wing RAF (Fighter-bomber)		
Nos 112, 250, 260 Sqns	Kittyhawk III	Mileni
Nos 3, 450 Sqns Royal Australian Air Force	Kittyhawk III	Mileni
No 5 Sqn SAAF	Kittyhawk III	Mileni
57th Fighter Group, USAAF (Fighter-bomber)		
64th, 65th, 66th Fighter Squadrons	P-40F	Foggia No 9 (Amendola)
79th Fighter Group, USAAF (Fighter-bomber)		
85th, 86th, 87th, 99th Fighter Squadrons	P-40F	Foggia No 3 (Salsola)

about 2,000ft [600m] pull up; count one, two and then release the bomb or bombs. Then we were to reform at about 5,000ft [1,500m] in the same formation back to base. The dive was at about 60° but felt like 90! Strafing was, of course, from low level. We followed each other down on to the target or targets. Sometimes dive-bombing would be followed immediately by strafing at ground level before re-forming."[1]

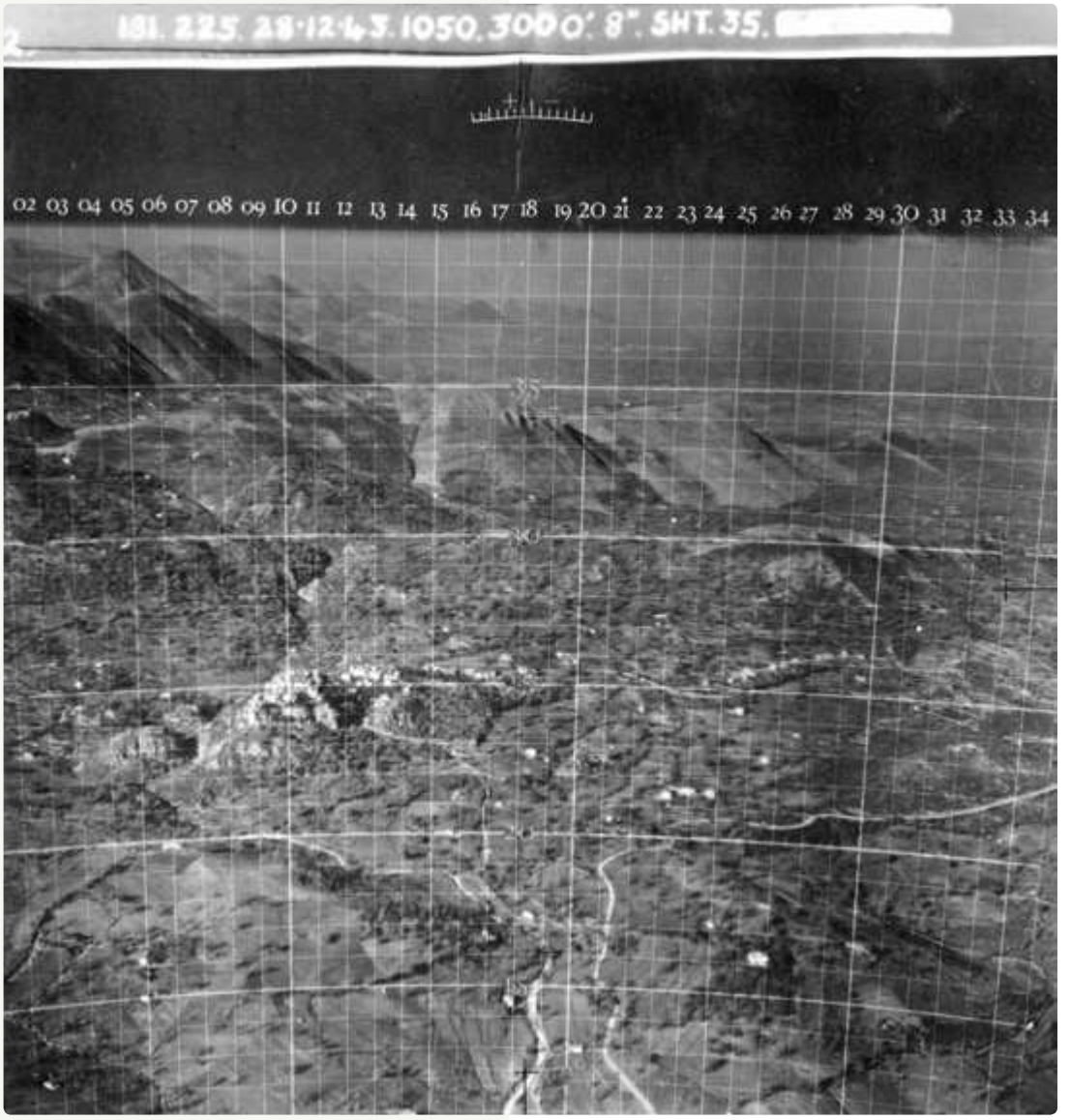
Developments in air support were to become critical, as the war in Italy proved tougher than expected, with appalling weather, fanatical German defence and the withdrawal of Allied units for the Far East and the impending landings in northern, then southern, France. Coastal Air Force was responsible for air defence, as well as maritime reconnaissance and protection, and as such it included day- and nightfighter squadrons based around Foggia. This relieved the Desert Air Force (DAF) Spitfires of any significant defensive role, and over the next few months the Spitfire fighter Wings began to adopt the fighter-bomber role, starting with No 4 Sqn South African Air Force (SAAF), which retained its Mk Vs for the purpose. From now on the Spitfire units were essentially multi-role, still providing cover for ground-attack and short-range bomber missions.

An important change to the inventory was the introduction of the Spitfire Mk VIII, which featured a strengthened airframe to accommodate the more powerful Merlin 61-series engine, new radiators and a retractable tailwheel. The Merlin variant installed dictated the role; indeed, DAF orders of battle, when listing Spitfire VIII units, qualified each entry with the mark of Merlin operated by a given squadron. Thus the standard fighter employed the Mk 61 or 63, high-level Mk 70 and low-level Mk 66. Armament was four 20mm cannon (usually reduced to two) plus four machine-guns, two 250lb bombs under the wings and a 500lb bomb on a fuselage centreline pylon. Many pilots considered the Mk VIII Spitfire to have been the finest. Little known is that some Mk IX squadrons fitted redundant Mk VIII main undercarriage legs on a handful of their aircraft to enable carriage of a greater bombload.

From March 1944 the North American Mustang Mk III began replacing the Kittyhawk. It was faster, had greater range and was better able to handle itself in a dogfight, but lacked the bomb-carrying capacity of the Curtiss aircraft. For the future in Italy, No 239 Wing would undertake most of the heavier or longer-range missions.

POST-SANGRO ANALYSIS

On December 5, 1943, Gp Capt David Haysom wrote a report on the *Rover* system, in which he highlighted the plan and its effectiveness.[2] Noting



VIA AUTHOR

MAJOR JOHN R. MERTON

JOHN RALPH MERTON was born on May 7, 1913, and after Eton he studied art at Ruskin College. A gifted artist and photographer, Merton was commissioned in the Royal Artillery in 1940, before being appointed to head the Research Unit at the Gunnery School at Larkhill. In June 1940 Merton met Maj H.C. Bazeley, then responsible for developing the Air Observation Post (AOP) role. They worked together on a system of oblique photographs taken from the air and then numbered and gridded (a rare example of which is seen **ABOVE**).

Merton went on to head the Army Photographic Research Branch, where he worked on using film to interpret the depth of water on beaches, critical in planning amphibious landings. His wartime work was recognised with the award of an MBE in 1942 and the American Legion of Merit in 1945. Post-war he became an established and prolific portrait artist. **VF**

that little of the available fighter-bomber resource had been used hitherto on the immediate front line, he referred to the speedier system for dealing with obstacles to the advance of forward elements, such as machine-gun nests and anti-tank guns. Haysom refers to the use of gridded 1/250,000 maps, so there remains some doubt as to whether the gridded oblique photograph system devised by Maj John Merton (see panel at left) and first used in April 1943 was in use by the Kittyhawk pilots at the time. *[For more on this system see* Rover David Pt 1 *in* TAH34 *— Ed.]*

At Sangro, in terms of the advanced "tentacles" and observation posts, the system worked. Via telephone link the controller was able to have a clear idea of the battle situation and the intentions of all divisions involved. There were initial problems with overloading on the VHF channel

HOWARD LEVY

Spitfire HF.VIII JF447, coded UF-7, was the personal mount of Sqn Ldr Stanisław Skalski, CO of No 601 Sqn, part of the RAF's No 244 Wing, and is seen here at Gerbini, Sicily, on October 3, 1943. The squadron moved to Tortorella in south-western Italy two days later and on to Foggia-Triolo on October 18. Note the extended wingtips of the HF.VIII for high-altitude operations; standard Spitfire wingtips or clipped wings for low-level operations could be fitted.

coupled with a transmitter fault, but this was remedied by giving the cab-ranks an alternate channel. The first day of the battle is referred to as an experiment, as revealed in Haysom's report:

"As had been experienced in previous battles, only one call for support was made during the day and all targets attacked were obtained by constant reference to the divisions concerned. The targets were not very closely linked with the immediate engagements of our forward troops and the day was, on the whole, an experimental one both from the point of view of wireless communication and the tactical possibilities of the scheme. Surprisingly little difficulty was experienced by the controller in indicating targets to the aircraft, and the pilots appeared to find the grid extremely easy and helpful to employ."

Haysom records that on the second day, operations were more effective, with at least three calls on targets, including machine-guns, right on the forward defended line (FDL): "The [General Officer Commanding of the] 78th [Infantry] Division, who had requested that these targets be attacked, was most impressed and enthusiastic regarding this form of close co-operation".

While both divisions were given support, the nature of terrain before the 8th Indian Division was such that targets were further forward of the FDL. By the fourth day, however, targets were beyond visual sighting of the forward observation posts (OPs) which, coupled with the fluid nature of the battle and imminent move of Divisional HQ, brought the operation to a conclusion.

There were three conditions described that would need to be addressed before the process could be repeated. First, communications with Army formations needed to be comprehensive and reliable; second, the battle area should be

VIA AUTHOR

ABOVE Rover ***control typically used a Bedford truck, as seen here with a VHF aerial. Over time the roving controller operated from several types of signals vehicle, ultimately settling on the artillery "Quad".***

clearly visible to the controller; and finally, radio communications with the aircraft should be guaranteed. Given previous Army complaints about the lack of immediate air support, the inability of the forward troops to use their air support properly is surprising.

Haysom's report also noted the following:

"As had been anticipated, very few support calls were made by the forward troops and the elaborate briefing which had been stipulated was not brought into use. This meant that for all the targets attacked, forward troops were not aware of the impending arrival of our own aircraft and displayed no indicator to show their position. Owing to the familiarity of the pilots with the terrain and the successful use of the grid previously referred to, no cases occurred of attacks being made on our own troops. However,

The ubiquitous Stinson L-5 Sentinel entered USAAF service in December 1942, initially as the O-62. The installation of VHF radio equipment in the* Horsefly *Sentinels enabled their pilots to talk directly to circling fighter-bombers, whereas the RAF's Auster pilots had to pass all instructions through the ground-based* Rover *system.

ALPHA ARCHIVE

had the pilots been unfamiliar with the battle area, it would have been quite impossible to deliver attacks as close to forward elements without some assistance from them in the way of smoke or some other device. The existing arrangements by which all indicators are displayed at Brigade Headquarters, as they are the lowest formation provided with a tentacle, still does not bring the indicator close enough to our own forward troops to obviate errors of the order of a half-mile to a mile, which might be disastrous. A solution to this problem is being worked on."

The squadron commanders were confident in the new arrangements, asking only for larger-scale maps and better radio communications. The vehicle available for the forward controller was not deemed satisfactory and would in future be a four-wheel-drive artillery "Quad". The *Rover* system was thereafter used extensively, typically during the Cassino battles in the first five months of 1944.

THE AMERICAN HORSEFLY SYSTEM

One important innovation evolved from the Americans' experience. In the summer of 1944 the Americans had applied the British *Rover* system, in their case with the callsign *Rover Joe*. However, they identified circumstances in which it was not just useful, but positively essential, for mobile ground units to be able to communicate with fighter-bombers in order to ensure that they were not attacking Allied units close to the front line.

At this stage with mobile warfare, the bomb line — a notional line just ahead of the front line of advancing friendly forces — was anything between five and ten miles (8–16km) ahead of the forward troops, or 10min ground-travel time. It was therefore determined to have a nearer close-support line, but this only worked with regular and frequent inputs of data from front-line units. With highly uncertain and fluid movements, a system of airborne forward fighter-bomber control was developed using USAAF Stinson L-5 Sentinel spotter aircraft.

These were flown by liaison unit pilots or fighter-bomber pilots on loan and were equipped with SCR-522 VHF radio. An observer was carried who, subject to the nature of any advance and the likely lead units, might be an infantry or armour officer, who would be able to distinguish friendly from enemy units from the air. The L-5's wing upper surfaces were painted in distinctive colours and the aircraft operated under the callsign *Horsefly*. The first such mission was recorded on June 28, 1944.

In practice, if a target ahead of forward troops was spotted, the aircraft would either call the Fire Direction Centre asking for artillery or fighter-bomber support, or if the latter was already in the air and nearby, would call them in direct and sometimes mark the target with a cluster of rifle grenades. The L-5s operated up to 20 miles (30km) ahead of the front line and up to 4,000ft (1,200m). Born of necessity when there were too many fratricidal strikes, the system did not find favour with the British.

From July 1944 the British air observation post (AOP) squadrons were drawn into the *Rover* system, which was itself being extended. RAF Auster pilots were now able to call in to the *Rover* network, via their Army Group Royal Artillery (AGRA) unit, any target that might not be visible to artillery, not spotted by tactical reconnaissance (Tac/R) sorties or perhaps on the move or otherwise not appropriate for guns on the ground. Subject to the ebb and flow of battle,

LEFT ***A USAAF pilot of the 47th Liaison Sqn poses beside his Sentinel,*** **Vegas Belle.** ***Although the*** **Horsefly** ***system's direct contact between air observation post and fighter-bombers appeared to offer an advantage, there was a grave risk of Allied ground troops being on the receiving end of friendly fire owing to a lack of tactical oversight of the battlefield as a whole.***

BELOW ***The American Secretary of War Henry L. Stimson in the back of an L-5 Sentinel before an observation flight over US Fifth Army positions in the Cecina area of Tuscany in the summer of 1944.***

ALPHA ARCHIVE x 2

overflying fighter-bombers could be brought down on such a target very quickly indeed, and frequently were. The British approach was in contrast to the American *Horsefly* system.

The USAAF used the L-5 to call down circling fighters directly on to relevant targets. While this might seem efficient and immediate, the approach was not adopted by the RAF and British Army. The problem with a forward air control (FAC) system is that to be effective, the FAC pilot must be well-briefed on the battle and quite clear about where the bomb line is — not always easy in a fluid situation. In general, American fighter pilots had a reputation for carelessness when it came to shooting at friendly forces. In addition, the FAC may also run the risk of wasting scarce resources on a relatively minor target.

With the British system, possibly to some extent forced by weight limitations involved in carrying an additional VHF radio, the AOP pilot had to report suitable targets indirectly to fighters via *Rover* control. The latter could then place the target in a wider context, would know of possible other demands on the circling fighters and could then instruct accordingly. The British system, although marginally slower, was thus safer, more focused and applied air support in context.

VARIATIONS ON A THEME

By the end of the war in Italy there were numerous refinements of the basic *Rover* control system. There were two primary *Rovers* working with the British Eighth Army: *Rover David* and latterly *Rover Paddy*.[3] (The latter was briefly *Rover Jimmy*, which caused confusion as *Jimmy* was the callsign of a SAAF Wing.) The British also utilised *Rover Frank*, operational from September 18, 1944. This was a specialised control solely tasked with handling attacks on German artillery. The *Rover Frank* control was based with Commander Royal Artillery (CRA) Eighth Army HQ and included an air force controller and artillery counter-battery officer. At the end of each day a target list was drawn up for air attack, and when airborne, the fighter-bombers were to call *Rover Frank* for updates and any possible change of target. Forward Observation Officers were attached to *Rover* teams and empowered to direct artillery on to targets close to the bomb line, or order coloured smoke to mark targets for the aircraft.

The Americans had *Rover Joe*, run on broadly similar lines to *Rover David,* and by April 1945 there was an additional American control, *Rover Pete*.[4] Where ground observation posts were difficult to find, the Americans used the *Horsefly* system. For a brief period from the end of March 1945 there were two additional systems: *Rover Jack* was established to support XIII Corps and *Rover Tom* was the Army Group Polish Artillery equivalent of *Rover Frank*.

TINUS LE ROUX VIA AUTHOR

ABOVE ***The Austers of the four RAF squadrons in Italy played an important part in the* Rover *system. Flown by Army pilots from advanced landing grounds, they could call in fighter-bombers to attack targets out of sight of ground controllers via their Army links. Seen here is Auster III NJ908 of No 651 Sqn, attached to the Army's V Corps.***

The American Fifth Army also operated a system described as *Midnight Rover* that was quite different from a standard *Rover*.[5] One Douglas A-20 and three North American B-25s fitted with radar were equipped for night photography. The A-20, fitted with a flash unit, flew at 1,500ft–3,000ft (450m–900m), while the B-25s, using magnesium flares, flew at 7,500ft (2,300m), all seeking nocturnal targets including ferries, temporary bridges, troop movements or concentrations and motor transports. Once a target was found and photographed the aircraft flew straight to its advance base, where the film was processed, but not printed, and immediately interpreted. Positive results were relayed to the Tactical Control Centre, which would then call on XXII Tactical Air Command or the DAF for aircraft on standby or airborne to attack.

The cab-ranks remained the key air element, but they changed slightly in composition and in the way in which they were directed. There was now sometimes a reduction from six-aircraft flights to four or even three aircraft, in part because of the greater individual hitting power of the USAAF's Republic P-47 Thunderbolt fighter-bomber. Most of the changes related to targets to be attacked after any initial sterile 20min cab-rank orbit. In some cases the predetermined alternate target was abandoned in favour of an alternative designated by *Rover*, but not necessarily one immediately facing troops in battle.

One such alternative was for *Rover* to free the cab-rank from its pre-briefed alternate to select a safe target close to the front line after the initial period. Some cab-ranks were used as armed reconnaissance missions that gave them freedom to find their own targets close to the front line from the outset, with no pre-briefed alternate. Other cab-ranks were handed over to Tac/R fighters which identified and marked targets. If there was a strict system, it was not always applied. Thus, while there was a system, it was adapted in the field to meet local circumstances with no need for any policy change from above, or even a formal record, aside from the operational record book (ORB) entry.

A SPOT OF BUCCANEERING

There is evidence that towards the end of the war in Italy the fighter-bomber squadrons generally preferred free-ranging armed reconnaissance to the discipline of the cab-rank. No doubt there were some occasions when the alternate was simply discarded by the leader for a spot of buccaneering. There were also occasions when the cab-rank leader spotted a target and sought approval to attack. This extract from the No 241 Sqn ORB, relating to a four-aircraft mission on the morning of April 21, 1945, provides an example:

"Briefed for *Rover Paddy*. As *Rover Paddy* was leading up to target area, leader reported an armoured car stationary at [map grid ref] M.212797. *Rover Paddy* gave his permission to bomb; four aircraft bombed south-east to north-west, 7,000ft–1,000ft [2,100m–300m], TOB [time of bombing] 0900hr."[6]

By the closing weeks of the war in Europe the *Rover* system had descended almost into a free-for-all as the Allied armies drove north. This example, again from No 241 Sqn, exemplifies the

VIA AUTHOR

ABOVE ***Each armed with a single 250lb bomb, a flight of Spitfire Mk VCs of of No 2 Sqn SAAF, part of No 7 Wing SAAF, heads out for another close-support mission in Italy. Although fast and agile, the Spitfire was less than ideal as a dive-bomber — for more on why, see Donald Nijboer's article*** **Square Peg . . . Round Hole *in* TAH12.**

situation and relates to a four-aircraft mission on April 23, 1945:

"*Rover Paddy 2* gave bomb line Bondeno north along River Panaro to the Po and north-west to [map grid ref] L.850985 and instructed aircraft to attack all movement north of this line. L.898977 — 1 M/T [military motor transport] moving north, past four stationary half-tracks facing north, bombed by all aircraft [from] east—west, 7,000ft–1,000ft, TOB 0715hr. All bombs within 15yd of vehicles — one direct hit cratering road. Two strafing runs. No signs of M/T. Claim four half-tracks damaged by strikes — one M/T destroyed.

"F.910000 — two four-horse gun teams moving north, guns camouflaged with branches and only rough outline seen. Strafed by two aircraft — one team hid among farm buildings. The other chased into a field. Horses killed and gun limber damaged by strikes. Also strafed one horse-drawn vehicle — claimed damaged."

DIXIE, TIMOTHY, PIG AND PINEAPPLE

Specific close-support systems that relied on *Rover* support included *Dixie, Timothy, Pig, Pineapple* and *Pineapple Sundae*. In July 1944, as they continued to press towards Florence, the Allies had been slowed by strong German defence, poor weather and booby traps. The Germans tended to withdraw at night into fresh defensive positions, the attackers then taking most of the daylight hours to prise them out and back to the next defensive position. A solution was found with the introduction of a modified close-air-support system highlighting the speed and spontaneity possible with the Eighth Army and the DAF.

A cab-rank was overhead the front line during 1900hr–2030hr each evening with a Tac/R fighter searching for retreating targets. The *Rover David* system was used to call in the cab-rank fighter-bombers on likely targets spotted by Tac/R, although on occasion these would be checked with forward ground-based observation posts. The revised approach was named *Dixie* and the concentration of effort where and when it was required was highly effective. On July 16, 1944, for example, there were 14 *Dixie* operations involving 84 sorties against concentrations of M/T, tanks, artillery and a local HQ.[7]

Timothy was an intensive fast-and-furious "blitz" on enemy positions, with co-ordinated waves of fighter-bombers tackling individual targets just beyond a clearly marked front line. There were key features of this approach.[8] First, air strikes had to be closely tied to a ground offensive. Second, the ground formation had to give clear information on positions, targets and timing. Finally, safety factors had to be observed rigorously. The latter referred to the way in which *Rover*, which was key to the whole *Timothy* operation, related to the strike formations. Once the fighter-bombers were in the area, 5min before the planned attack time, *Rover* gave word to the artillery for the bomb line to be marked with smoke and then authorised the strike; he could also call it off immediately. Pilots were instructed that they may not bomb until the bomb line was clear and permission had been given by *Rover*. The most important characteristic of *Timothy* was its flexibility.

Pig was a similar process to *Timothy*, but with

TAH ARCHIVE

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the use of guns only, typically when the cloudbase was too low to enable bombing.

Pineapple was a system in which fighter-bombers were on close call to follow up on mobile targets identified by a Tac/R flight, either called in by control or possibly *Rover*. *Pineapple Sundae* used orbiting fighter-bombers already on station. *Toby* was a system designating briefed targets that had the potential for holding up an advance. These were notified to the fighter-bomber Wings and, if the target proved troublesome, would be attacked with about 90min notice.

POSTSCRIPT

From the first small biplane cab-rank in East Africa in the spring of 1941, through shared battle plans and a combined Army Air Support Control by El Alamein, plus policy-breaking front-line support at El Hamma in the spring of 1943, to the first *Rover David* at the Sangro River, the close air support system went from strength to strength. It was relatively simple, based on common sense and good practice and the energy and attention to detail of one man, David Haysom. It was embraced by three tactical air forces that included American, Australian, Brazilian, British, Canadian and South African squadrons and many more nationalities flying within them.

Rover was flexible, and its application culminated in the greatest close-air-support operation of all time, on April 9, 1945, when *Rover* control orchestrated not just fighter-bombers, but the AOP squadrons and light, medium and strategic bombers against a couple of square miles behind the Senio River, south of Bologna, in Operation *Wowser*. In 24hr some 2,130 sorties were conducted. The system matured with flair befitting an Italian adolescence, away from immediate oversight from London. The DAF, within which *Rover David* was hatched, was democratic and easygoing, and a combination of initiative and experimentation at local level probably contributed as much to the system as the policies of those in command.

ABOVE LEFT ***The architect of the "cab-rank" and* Rover *systems, South African David Haysom, seen here as a Flight Lieutenant during the Battle of Britain. Haysom was posted to the Middle East in mid-1942, taking command of No 239 Wing in the Western Desert. He was awarded the DSO in February 1943.***

And there the story ends. The *Rover* system evolved in the context of symmetrical warfare involving major set-piece battles between conventional forces. There was a brief trial within No 244 Wing in Italy at the end of August 1946 involving a VHF set installed in a No 654 Sqn Auster AOP Mk V, putting the *Rover* controller in the pilot's seat, but the RAF wanted ownership. In any event, with British forces involved in low-key insurgencies for many years post-war, there was no demand for elegant systems of air control.

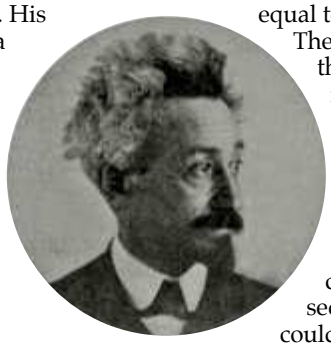
It might have been thought that the system would be dusted off and refined for application in the event of the Cold War turning hot, but institutional memories are short. New technologies and fresh minds lead to new doctrine, and it seems that Haysom's elegantly efficient *Rover David* concept has been confined to the shelves of The National Archives.

1 Horden, B., *Shark Squadron Pilot*, Independent Books, 2002, p51
2 The National Archives (TNA) ref AIR 23/1826, *The Rover Tentacle*
3 *Rover Paddy* was named after Gp Capt C.P. "Paddy" Green, a Battle of Britain South African RAF pilot who commanded No 1 Mobile Operations Room Unit from March 6, 1944
4 TNA ref AIR 41/58; RAF Air Historical Branch (AHB) narrative *The Italian Campaign*, Vol II, p297
5 AHB narrative *Close Air Support;* Air Publication 3235, 1955, p118
6 TNA ref AIR 27/1466
7 Jackson, W., *History of the Second World War: The Mediterranean and Middle East Vol VII, Part II*, Naval & Military Press, 2009, p85
8 Air Publication 3235, op cit, p120

FRANCE'S AIR PIONEERS: LOUIS CAPAZZA

French aviation historian **JEAN-CHRISTOPHE CARBONEL** continues his series on "those magnificent Frenchmen" who risked their reputations, fortunes — and often lives — to further the cause of aviation across the Channel. This time he examines the scientifically dubious "flying saucer" concept of Corsican Louis Capazza; it flew — but only in the pages of an 1894 sci-fi novel

LOUIS CAPAZZA (**INSET BELOW**) was born in Bastia, Corsica, on January 17, 1862. Nothing is known about where he studied but he worked as an *agent secondaire de 1ère classe* in the French *Service des Ponts et chaussées* (Department of Civil Engineering). He came to the notice of his superiors by inventing cartographical instruments, which he was sent to Paris to present to the central offices. While in Paris he developed an interest in ballooning. His aerial career began in 1886, Capazza completing many ascents in Paris and Ajaccio on Corsica, flying aboard his own balloon, the *Gabizos*, named after a mountain in the Pyrenees. On November 14 that year he earned the distinction of being the first aeronaut to fly from Marseilles to Ajaccio.



THE SYSTÈME CAPAZZA

The previous year Capazza had published details of the *lenticulaire Capazza,* a disc-shaped aerostat (lighter-than-air flying-machine), in the November 20, 1885, issue of the *Journal Barral*. The lenticulaire comprised two flattened cones of light metal construction linked by a bellows. The contemporary press, ever-eager to herald new inventions, claimed that Capazza had "boldly turned away from the wrong direction and launched himself into a new way which may be the right one".

Capazza's idea was to modify not the weight of the aerostat — as had been done so far by the use of ballast weights — but its volume. He explained: "By increasing the volume by one cubic metre, one can create as much lift as by dropping one kilogram of ballast". After taking off, the aerostat was to be capable of horizontal motion, for which Capazza also harboured original ideas, even if they were already circulating at the time.

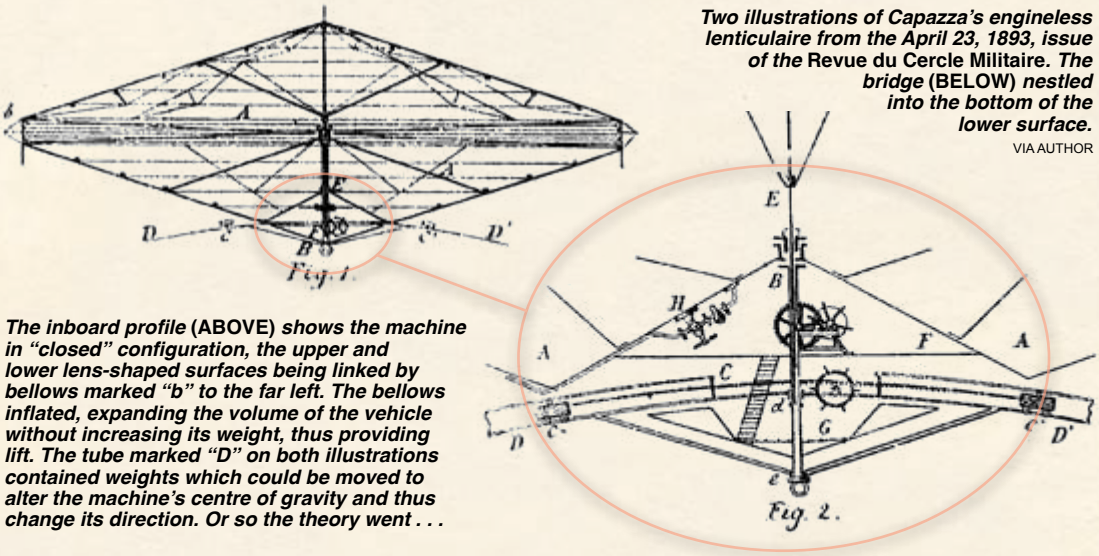
Capazza claimed to have been influenced by the observation of the flight of swallows:

"The swallow, with its lean body and thin wings, the whole ensemble in the shape of a cross, gives itself to gravity and, without moving its wings, can fly horizontally more than 50m [160ft] before climbing back to a height nearly equal to the height of its departure point. The speed of the horizontal flight of the swallow would be even greater if the area between the wings and the body was filled . . . the optimal shape to obtain being an infinitely thin disc."

To move the lenticulaire, Capazza envisioned fitting it with a weight, movable along a curved rail placed in the lowest section of the aerostat. The rail itself could be rotated towards the intended direction of flight. The idea was to alter the centre of gravity of the machine and thus force it to glide downward in the required direction. With this device Capazza hoped to obtain high speeds without an engine. This phase of the flight was called *vol plané* (gliding flight). The phrase caught on and was later used for all powerless flight.

The *Journal Barral* article indicated that the invention was to be presented to the Russian Aerial Navigation Committee in St Petersburg by General Konstantin Mikhailovich Boreskov, one of Russia's early aviation pioneers, and another party described only as "an immensely rich person who knows how to use his fortune for great enterprises". It is unknown if the presentation actually took place.

In 1887 Paul Vibert, in his book about transport



Two illustrations of Capazza's engineless lenticulaire from the April 23, 1893, issue of the* Revue du Cercle Militaire. *The bridge* (BELOW) *nestled into the bottom of the lower surface.
VIA AUTHOR

The inboard profile* (ABOVE) *shows the machine in "closed" configuration, the upper and lower lens-shaped surfaces being linked by bellows marked "b" to the far left. The bellows inflated, expanding the volume of the vehicle without increasing its weight, thus providing lift. The tube marked "D" on both illustrations contained weights which could be moved to alter the machine's centre of gravity and thus change its direction. Or so the theory went . . .

vehicles, devoted a mere 12 lines to the experiments of Arthur C. Krebs and Charles Renard, who had designed and flown the dirigible *La France,* the first flying-machine to take off and return to its point of departure in August 1884 — but he devoted five pages to the lenticulaire Capazza, opining that "the question of aerial navigation was completely stationary when the aeronaut Louis Capazza made a decisive step forward".

In a new variant, Capazza added a "parachute-ballast" of dubious scientific credibility to the design: "If when the balloon has reached a certain height and no longer climbs, a parachute weight is dropped, the parachute opens by the resistance of the air and slows down the fall of the weight. At the same time, the aerostat, with this weight removed, regains its lifting strength. [The parachuted weight remained attached to the balloon through a rope.] When the rope is taut, the weight has reached the end of its course; by way of the acquired force, the balloon still climbs for a time and it is possible to winch the weight back aboard. Thus there is no need for more ballast weight [i.e. sandbags] because the parachute-weight can be used repeatedly."

Capazza's concept was an attempt at a form of perpetual-motion device, according to Paul Vibert. Perhaps unsurprisingly, this was to be the end of the lenticulaire, which used too much dubious science to be actually workable.

A SCIENCE-FICTION SUCCESS?

In 1894 the lenticulaire finally flew — in the pages of a novel. In *l'invasion noire* ("The Black Invasion"), *Commandant* Emile Driant, under the anagrammatical *nom de plume* Capitaine Danrit, describes a future war between France and allied African states (which at the time were European colonies). Driant was a specialist in lengthy future-war novels, pitting France against every

CAPPAZZA LENTICULAIRE, 1893

Type Lenticular aerostat without engines
Construction Two flattened cones of 2mm-thick copper sheet, capable of sustaining an internal pressure of 4·568kg/m², linked by bellows

Dimensions
Diameter 60m (197ft)
Height 22·5m (74ft)

Weight
Take-off 20,000kg (44,000lb)

Source: *Revue du Cercle Militaire*, April 23, 1893

ABOVE ***One of Paul de Sémant's dramatic illustrations of the super-airship* Le Tzar, *inspired by Capazza's concepts, published in the 1894 science-fiction novel* l'invasion noire *by "Capitaine Danrit" (Emile Driant).***

LECTURES POUR TOUS VIA AUTHOR x 2

ABOVE ***A poor-quality but rare photograph of Louis Capazza (right) demonstrating a collection of models of the Clément-Bayard Planeur in various configurations to an unknown companion. Capazza lived in Belgium during 1891–1904 and received the*** **Croix de chevalier de son ordre** ***from King Léopold II for research on balloon safety.***

antagonist he could imagine. Before and after the First World War he was a bestselling author in France, and his books were awarded as prizes to studious French schoolboys. In *l'invasion noire* Driant introduces the super-airship *Le Tzar*, clearly modelled on Capazza's design.

The novel describes *Le Tzar* thus:

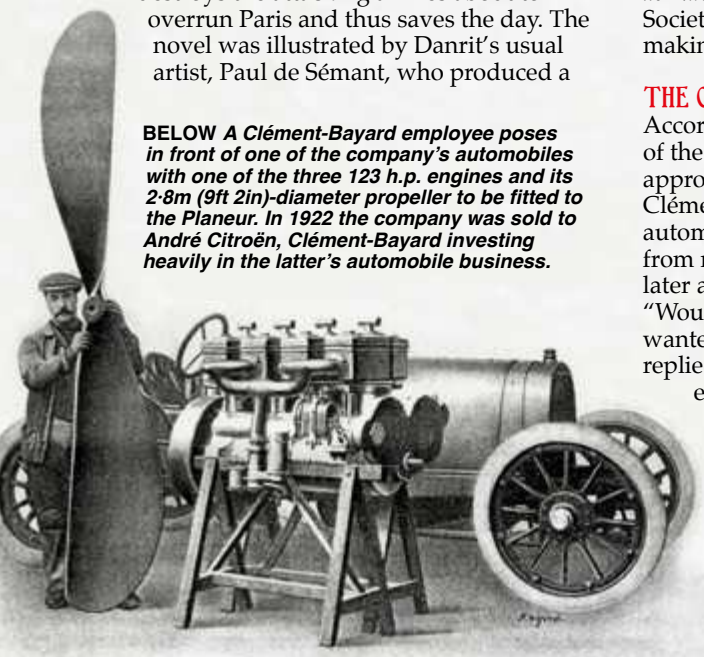
"The huge lens was full of hydrogen, the lifting force of which was enough to raise its 24,000kg [53,000lb] to 2,600m [8,500ft]. The original idea of this device and its working principle belonged to aeronaut Capazza, whose parachute demonstrations were moving experiences, and whose bold trips above the ocean cannot be forgotten. The Capazza lens, of a shape similar to the one belonging to *Ingénieur* Durville [the hero], was of red copper; above the gondola installed in the bottom of the lower cone, a curved rail received a balancing weight which could be directed from the gondola itself."

In the novel, *Le Tzar* is captured by the villain of the story and turned against its original owners. In the end, a fleet of lenticulaires destroys the attacking armies about to overrun Paris and thus saves the day. The novel was illustrated by Danrit's usual artist, Paul de Sémant, who produced a few renditions of *Le Tzar*. Driant dedicated the novel to Jules Verne.

In 1890 Capazza proposed the establishment of an office to centralise meteorological observations, and the following year he was among the founders of the *Aéro-club de Belgique*, moving to Belgium, where he stayed until 1904. In 1892 he invented a parachute that covered the upper hemisphere of a balloon. In case of deflation of the balloon, the parachute took over as lifting device and could bring the aeronauts back to *terra firma*. Capazza demonstrated the device on July 12 that year. Taking off from the grounds of the gas factory in La Villette in the northern suburbs of Paris, he deliberately punctured the envelope of his balloon and landed by parachute in nearby Drancy.

Capazza adapted his "aerial saviour", as he had named the device, to lift various meteorological devices fitted with recording systems into the higher layers of the atmosphere and then bring them back by parachute. Appointed Vice-President of the *Société Française de Navigation Aérienne* (French Aerial Navigation Society), Capazza became a renowned aeronaut, making 150 ascents between 1885 and 1904.

BELOW ***A Clément-Bayard employee poses in front of one of the company's automobiles with one of the three 123 h.p. engines and its 2·8m (9ft 2in)-diameter propeller to be fitted to the Planeur. In 1922 the company was sold to André Citroën, Clément-Bayard investing heavily in the latter's automobile business.***

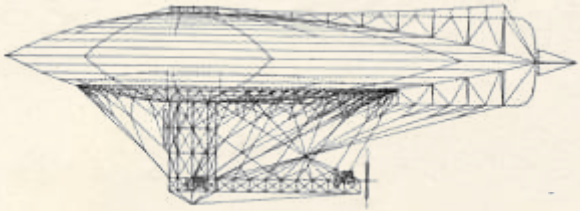


THE CLÉMENT-BAYARD PLANEUR

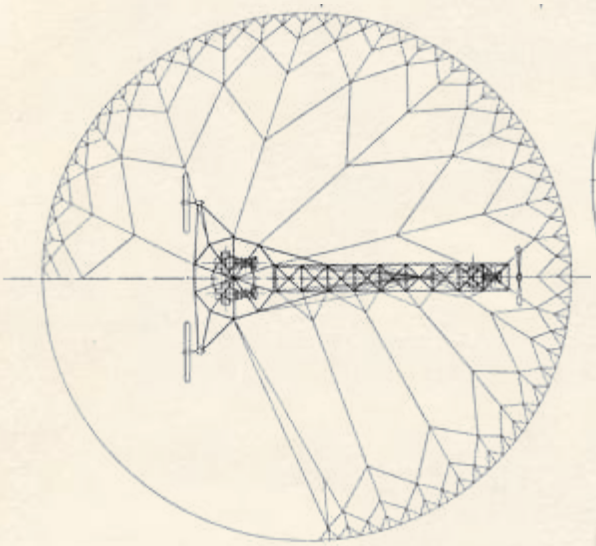
According to the 28th issue of the journal of the *Aéro-Club de France*, Capazza was approached by Adolphe Clément, founder of the Clément-Bayard company, at the 1904 Brussels automobile exhibition, who said, "You will hear from me, Monsieur". They met again two years later at the same venue; Capazza enquired, "Would it be time for you to talk about what you wanted to talk about two years ago?". Clément replied, "Right! It is time. Be at my factory in eight days".

Adolphe Clément (Clément-Bayard from 1909) was a successful French designer of automobiles and motorcycles. Starting his career as the agent of Dunlop tyres in France, Clément had the money to develop his car

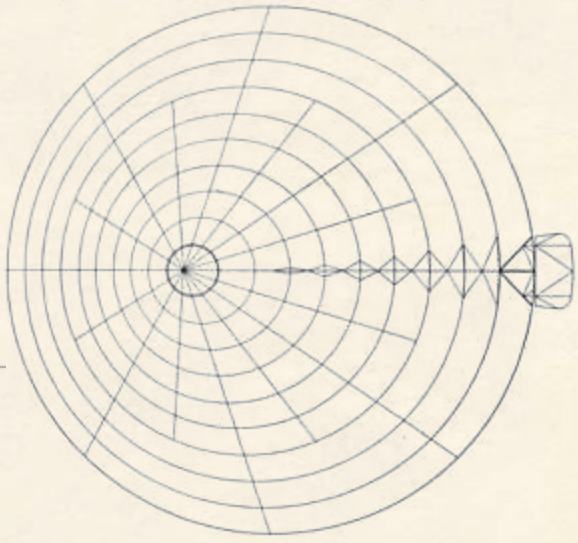
***Five illustrations from a Clément patent for the Planeur. Capazza's concept had clearly developed from his 1893 lenticulaire, with the copper structure being replaced by a slimmer envelope of broadly aerofoil-section, in which four toroidal hydrogen tanks were to be fitted, with a control gondola slung beneath. Although called the Planeur (glider), the machine was fitted with three engines, "to flatten the trajectory" as Capazza explained. Tobacco manufacturer W.D. & H.O. Wills featured the machine on a cigarette card* (BELOW).**



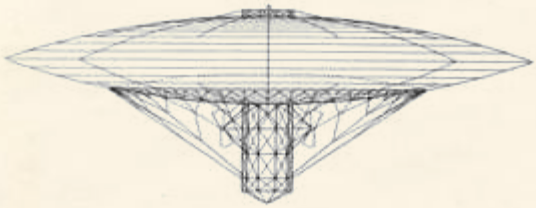
VUE LONGITUDINALE (LONGITUDINAL VIEW)



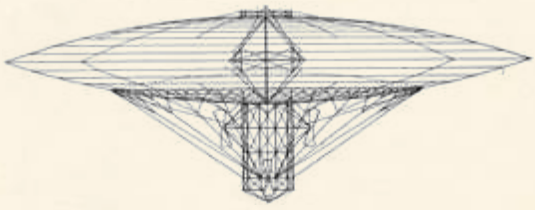
SUSPENSION GÉNÉRALE (VUE D'EN DESSOUS) – GENERAL ARRANGEMENT (VIEW FROM BELOW)



PLAN SUPÉRIEUR (PLAN VIEW FROM ABOVE)



VUE DE FACE (POSITION DES HÉLICES) – FRONT VIEW (POSITION OF PROPELLERS)



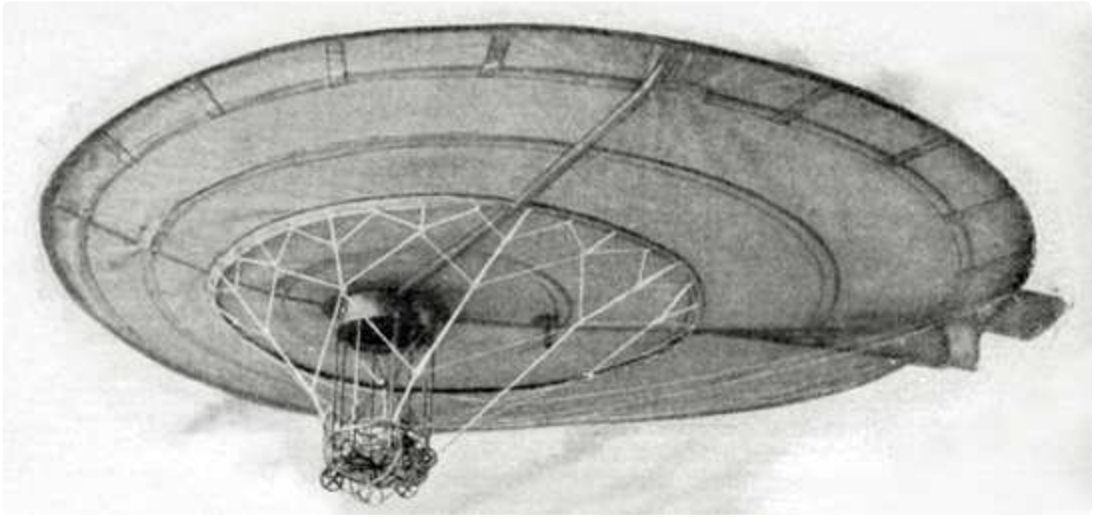
VUE PAR BOUT ARRIÈRE (REAR VIEW)

PLANEUR CLÉMENT-BAYARD/ CAPPAZZA 1906–08

Type Lenticular aerostat
Construction Doped fabric on steel tubing

Powerplant 3 x 123 h.p. Clément-Bayard piston engines

Lifting power	10,360kg	(22,840lb)
Dimensions		
Diameter	52m	(170ft)
Volume	9,418m³	(332,954ft³)
Weights		
Take-off weight with a crew of six	5,500kg	(12,100lb)
Performance (proposed)		
Maximum speed	unknown	
Service ceiling	2,000m	(6,600ft)



LECTURES POUR TOUS VIA AUTHOR

ABOVE ***An artist's impression of the Clément-Bayard Planeur in flight. Clément also established a working relationship with Brazilian aviation pioneer Alberto Santos-Dumont in 1908, the pair setting up production of the latter's Demoiselle No 19 monoplane — widely regarded as the first aircraft type to undergo series production.***

design business, and by 1906 he was ready to tackle the construction of flying-machines.

Throughout 1907 Clément and Capazza worked together on a new airship design, Capazza remaining faithful to his approach based on the flight of birds. Studying the works of ornithologist Étienne-Jules Marey, Capazza realised that acquired speed was a condition of gliding flight. Yet the new design, named the Bayard, was to be powered by three 123 h.p. engines fitted with large wooden propellers, each of 2·8m (9ft 2in) diameter. The engines came from racing cars designed by Clément.

The gliding idea remained, however, and the apex of the "lens" was not located centrally, the wing having a thicker leading edge and a thinner trailing edge — essentially an aerofoil section. A small elevator was fitted to the rear of the envelope. According to Capazza, the Bayard was neither an aerostat (lighter-than-air) nor an aerodyne (heavier-than-air); rather, it was lighter than air during the ascension phase and heavier during the gliding phase. Contrary to the all-metal lenticulaire, the envelope was of conventional fabric construction, but with a steel-tube structure forming a vertical cage. The gondola was 12·5m (41ft) long.

Capazza explained:

"Consider a kind of chimney which goes through the lens, just above the gondola. It incorporates a ladder through which I could climb to inspect the upper surface [during flight] and, retained by a rope, I could even let myself slide along [the upper] surface if urgent repairs required it. But mostly it was devised to watch the sky. I was always struck by the inability of aeronauts to see what happens just above them."

On June 18, 1906, Clément, without Capazza, applied for a patent describing the governing principles of the project, which revealed construction details not detailed elsewhere. For example, the inside of the lens contained four toroidal (doughnut-shaped) varnished-fabric hydrogen tanks, separated from the outer envelope by a plenum space filled with air to isolate the highly inflammable hydrogen from the outside atmosphere.

INTO OBSCURITY

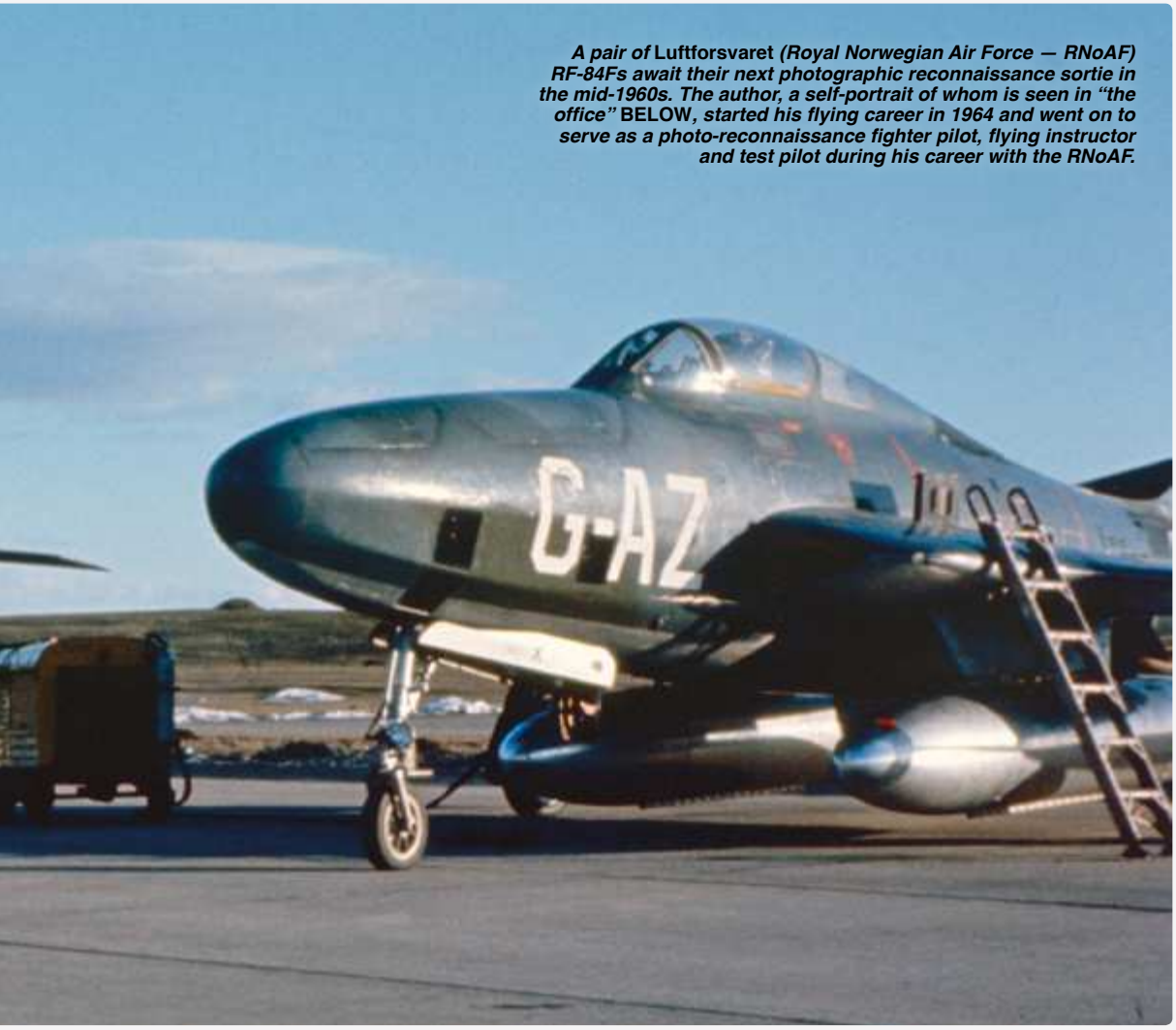
During 1907–08 a great deal of work was invested in this project. Scale models were constructed and tested and the engines were built and fitted with propellers. Clément was in charge of building the gondola and engines, while the envelope was to be constructed by the Astra Company, which went on to build other airships for Clément. However, the airframe itself was never finished, and there is no proof it was actually ever begun. Clément was occupied with numerous competing projects at that time, including a light engine for aviation, a propeller-driven car and the Clément-Bayard No 1 semi-rigid airship, which first flew in October 1908. The latter was clearly a better proposition than Capazza's strange lens-shaped *planeur* (glider) which remained at the mercy of the winds during the gliding phase (according to Capazza, the engines were there only to "flatten the trajectory").

As for Capazza, he became chief test pilot for Clément-Bayard and went on to set records and accomplish several firsts. In 1908 he flew over Paris and covered 200km (125 miles) in less than five hours. The same year he reached an altitude of 2,000m (6,600ft) in a dirigible. In 1910 he was the first to cross the Channel in an airship. He died in 1928, however, without realising his dream of a lenticular-shaped machine.

FLASH!

FLYING "THE IRON" – THE REPUBLIC RF-84F IN ROYAL NORWEGIAN AIR FORCE SERVICE

In the spring of 1956 the Royal Norwegian Air Force introduced the state-of-the-art Republic RF-84F Thunderflash photo-reconnaissance jet into service. **KAPTEIN KNUT LANDE**, who flew the type during 1966–69, traces the RNoAF career of the shapely Cold War jet and recalls what it was like to fly operationally



A pair of* Luftforsvaret *(Royal Norwegian Air Force — RNoAF) RF-84Fs await their next photographic reconnaissance sortie in the mid-1960s. The author, a self-portrait of whom is seen in "the office"* BELOW*, started his flying career in 1964 and went on to serve as a photo-reconnaissance fighter pilot, flying instructor and test pilot during his career with the RNoAF.

VIA NILS MATHISRUD

AUTHOR'S COLLECTION

ON AUGUST 9, 1949, No 1 Photo-Reconnaissance Flight of *Luftforsvaret* (the Royal Norwegian Air Force — RNoAF) was established at Gardermoen Air Station, today part of Oslo International Airport, with a trio of Supermarine Spitfire PR.XIs. The unit operated all over Norway, with frequent deployments as far north as Bardufoss and to Kjevik in the south. The final Spitfire sortie for the RNoAF was flown from Kjevik on March 25, 1954, after which the unit was disbanded.

It was, however, reactivated at Sola (Stavanger) in April the same year and allocated six Republic (R)F-84E Thunderjets to become No 717 Photo-Reconnaissance Flight. Although commanded by its own squadron leader, the unit was attached to resident fighter squadrons; first to No 338 Fighter Squadron (FS), then to No 334 FS, both of which flew F-84Gs. The unit operated the

VIA NILS MATHISRUD

ABOVE ***The RF-84F was a dedicated photo-reconnaissance development of Republic's F-84F Thunderstreak, the latter's nose air intake being replaced with wing-root intakes in order to free the nose for a comprehensive suite of photographic equipment. The resulting drop in performance was deemed acceptable for the photo-recce role.***

Thunderjets for two years without any serious accidents; quite a feat, as the F-84E/G suffered from a comparatively high loss rate.

ENTER THE THUNDERFLASH

In April 1956 the RNoAF started receiving examples of one of the era's most advanced photo-reconnaissance aircraft — the RF-84F Thunderflash. A total of 20 was received by September that year, and the unit was redesignated No 717 Sqn (Photo-Reconnaissance). Some 31 Thunderflashes would be taken on strength by the squadron during 1956–64. In the summer of 1961 No 717 Sqn (PR) moved to Rygge Air Station in southern Norway, where it was located until it was disbanded and merged with No 336 Sqn in August 1979.

The RF-84F was a comparatively complicated and challenging type to fly, operationally and technically. The sorties the type was used for were demanding, requiring accurate navigation at high speed at low altitude, often in poor visibility. Some 14 of the RNoAF's 31 RF-84Fs were lost in various accidents during 1956–69, but only one pilot was lost, when a Thunderflash flew into Skrimsfjellet, a mountain near Kongsberg, in poor weather conditions.

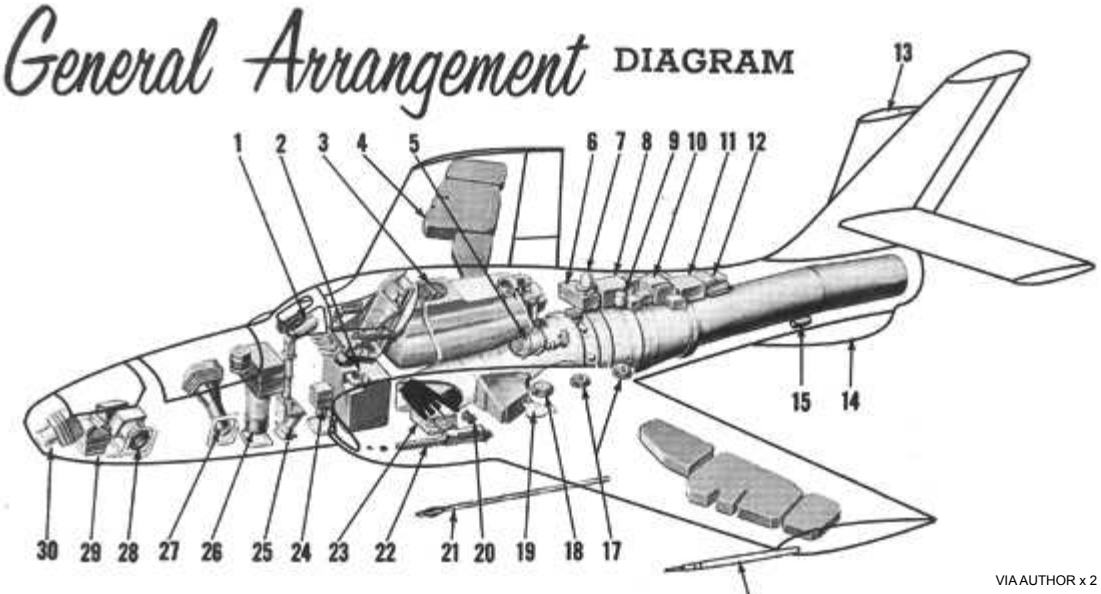
To increase pilot safety, the original Air Mechanics Inc ejection seats were replaced with Martin-Baker Mk 5 seats. Six pilots ejected safely with the new seats. Compared to other RNoAF fighter squadrons, however, No 717's losses were relatively low, which confirms the squadron's high operational and technical standards.

The RF-84F was equipped with two large camera compartments in the nose section. The type could thus be equipped with several cameras of various sizes for tactical as well as strategic use. For secret strategic sorties in Finnmark in north-eastern Norway, the RF-84Fs were equipped with large telephoto lenses, which made the type very suitable as Nato's "eyes" on its northernmost flank.

The cameras could be loaded with various

BELOW ***RNoAF Thunderflashes of No 717 Sqn (Photo-Reconnaissance) in their original bare-metal schemes and "T3" codes at Sola (Stavanger) in the late 1950s. The Thunderflashes were repainted in camouflage markings, as per Nato Standard No 3083,*** **Colouring and Markings of Aircraft for Tactical Reconnaissance,** ***circa 1959–60.***

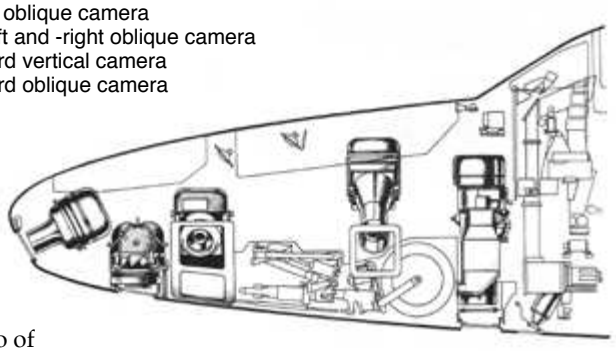
VIA NILS MATHISRUD



VIA AUTHOR x 2

1 Gunsight
2 Forward fuel tank
3 Main fuel tank
4 Wing fuel tank
5 Oil tank
6 Radio compass equipment
7 Radio compass loop antenna
8 Command radio equipment
9 Directional indicator equipment
10 IFF/ SIF radar equipment
11 Autopilot equipment
12 AN/APW-11 radar transponder
13 Command radio antenna
14 Drag parachute compartment
15 Emergency hydraulic compartment
16 Pitot tube
17 AN/APW-11 radar antenna
18 IFF/SIF radar antenna
19 Air refuelling receiver (unmodified)
20 Pneumatic compressor
21 Air refuelling probe (modified)
22 0·50in machine-guns
23 Ammunition bays
24 Camera photo cell
25 Viewfinder
26 Prime vertical camera
27 Aft left oblique camera
28 Mid-left and -right oblique camera
29 Forward vertical camera
30 Forward oblique camera

Although the wing-root-mounted air intakes on the RF-84F cost the type in terms of performance compared to the more efficient straight-through jetpipe of the Thunderstreak, the Thunderflash more than compensated in tactical terms by having an excellent photographic suite, as this contemporary pair of illustrations demonstrates.



types of film, including infrared film that could reveal camouflaged targets. Image quality from the large cameras was exceptional, especially when using the large forward-looking 36in camera with 9in x 18in film. Unsurprisingly, there were numerous requests from friends and acquaintances who wanted a nice aerial photo of their house or cottage!

The large camera compartments could also be used for purposes other than the strictly tactical. It was not uncommon for squadron members to pick up fresh seafood at Ørland in central Norway and Lista in the south for delivery to Rygge for squadron get-togethers. The camera compartments were temperature-controlled, and crabs particularly "enjoyed" the constant 20°C temperature, even at 20,000ft (6,000m) at 520kt.

CONSTANT READINESS

Standing at continuous readiness in northern Norway, No 717 Sqn (PR) deployed two aircraft on detachments to Bodø and Bardufoss at all times. It was popular among personnel at Rygge to order seafood from the Arctic when the aircraft were due to return to their home station. I once promised a meteorological officer at Rygge that I would buy 10kg of halibut in the north and bring it to Rygge on conclusion of my readiness period. I was returning to Rygge on a Saturday and the meteorologist was having a dinner party on the Sunday. In the briefing for the return flight the weather forecast for Rygge was poor and my departure was held back. I phoned the met office at Rygge where, by chance, my "customer" was on duty. I explained the situation and speculated that the 10kg of fresh halibut had very little chance of being delivered on time, as the visibility at Rygge was too limited to land. "How much visibility do you need?" asked the met officer. I explained that

VIA NILS MATHISRUD

ABOVE ***Four RF-84Fs of No 717 Sqn (PR) gleam in their bare-metal schemes in contrast to the characteristically steep-sided fjord in the background. As with most early turbojet-powered fighters, range was an issue, and the Thunderflash always carried a pair of wing-root-mounted 450 US gal (1,700lit) external fuel tanks for operations.***

ROLF BAKKEN COLLECTION VIA NILS MATHISRUD

LEFT ***Wearing squadron code T3-A, a Thunderflash undergoes maintenance in the late 1950s. Unique to the F-84F and RF-84F, note the articulation of the canopy, which is mounted on a pair of hydraulic rams and a lever arm, allowing it to pivot up and backwards behind the cockpit. Of typical Republic design, the RF-84F was built to be exceptionally robust, and was stressed to withstand some 9g.***

BELOW ***When the RNoAF's Thunderflashes were given camouflage colour schemes during 1959–60, the undersides were initially painted Nato PRU Blue. These examples are seen at Sola with the new camouflage scheme with blue undersides, but before the unit's code was changed from "T3" to "AZ" in 1962.*** VIA AUTHOR

AUTHOR'S COLLECTION

ABOVE ***Showing the F-84F/RF-84F's distinctive swept wing, of 38·5° sweep and with 3·5° of anhedral, and all-moving tailplane, RF-84F serial 52-9734, coded AZ-F or E, conducts another sortie over a typically rugged Norwegian backdrop. Much of No 717 Sqn's work was undertaken at low level over difficult mountainous terrain.***

I required 1km (0·6 miles) visibility and a 60m (200ft) cloudbase. "This you will get", the met officer replied, and published a revised weather report for Rygge. The following evening the met officer served his guests delicious fresh halibut brought directly from the North.

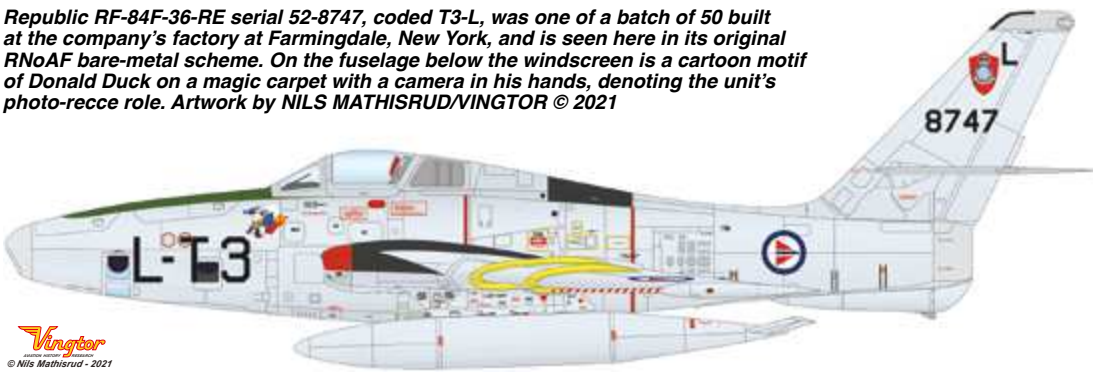
The RF-84F was an exciting aircraft to fly, but also very demanding. The sorties were of mixed type, and were much enjoyed by No 717 Sqn's pilots, who were proud to fly the Thunderflash, the unit being the only one to fly the type in RNoAF service. There was an excellent *esprit de corps* within the unit and a palpable sense of solidarity within its ranks. The squadron included a dedicated maintenance unit with highly qualified and experienced specialists in all areas, making the unit completely independent. General overhaul duties were undertaken by Fokker in the Netherlands, and ferry flights to the Low Countries were very popular among the pilots.

MINOR – AND MAJOR – INCIDENTS

During my service on the Thunderflash I experienced several instances of minor failures — and a couple of more severe incidents.

On February 27, 1969, I flew a tactical sortie from Bodø in Thunderflash code AZ-D. After flying south at low altitude for about 20min, the main electrical generator failed, followed shortly afterwards by the standby generator. Relying completely on the batteries, the electrical systems died after a few minutes. I returned to Bodø with a dead radio. I jettisoned the two full external fuel tanks into the fjord off Bodø, which made big splashes when they hit the sea

Republic RF-84F-36-RE serial 52-8747, coded T3-L, was one of a batch of 50 built at the company's factory at Farmingdale, New York, and is seen here in its original RNoAF bare-metal scheme. On the fuselage below the windscreen is a cartoon motif of Donald Duck on a magic carpet with a camera in his hands, denoting the unit's photo-recce role. Artwork by NILS MATHISRUD/VINGTOR © 2021



AUTHOR'S COLLECTION

LEFT ***Based on an original secret reconnaissance document*** **(BELOW LEFT),** ***this map shows the operating area of No 717 Sqn's Thunderflashes during Operations*** **Vega** ***and*** **Kornelius,** ***in which RF-84Fs would probe Norway's far northern borders with Finland and the Soviet Union. The legend on the original reveals that*** **Vega** ***operations (unbroken line) would be undertaken at 10,000ft–20,000ft (3,000m–6,000m). The broken blue line represents the eastern boundary of*** **Kornelius** ***operations, which would be undertaken west of the line and at varying heights. Map by MAGGIE NELSON.***

like bombs. I continued to Bodø where I landed without any radio communication.

A more dramatic incident occurred during a tactical photo sortie on August 6 the same year, over the Ringebu area, north-west of Lillehammer. Flying AZ-C, I was photographing with the forward-looking camera, when the engine died as I was pulling out of a gentle dive. I switched to emergency fuel control and attempted an air start. Nothing happened, and the aircraft started to lose height. I switched back to the main fuel control and tried again. I was descending towards a valley at an altitude of about 600m (2,000ft) and realised I had only one attempt at restart left before I would have to eject. My airspeed had now decreased to 190kt and power was at 19 per cent of full r.p.m. The engine restarted and I felt the aircraft come back to life. Despite feeling somewhat impatient, I let the rotational speed increase before I carefully pushed the throttle to full position.

To my great relief, the instruments indicated that the engine was back in business. I pulled the stick back to climb and passed a ridge with about 150m (500ft) to spare. I transmitted an emergency message and headed south towards Rygge, while climbing steadily to safe altitude over Lake Mjøsa. Climbing out of the cockpit after landing at Rygge, I felt rather shaky, but still very happy for not having had to depart from my Thunderflash over Ringebu.

A FIGHTER PILOT WITH BRAINS

The sorties we performed were very diverse, but the most common involved tactical photo-reconnaissance. The pilots planned for a tactical navigation sortie of about 1½hr. With the squadron's Photo Interpreter (PI), the pilot

A line-up of Thunderflashes in the early 1960s, after No 717 Sqn's adoption of "AZ" codes. The RNoAF constitued an important part of Nato's ability to monitor its northern flank, Norway and the Soviet Union sharing a 196km (122-mile) border between Norway's Sør-Varanger municipality and the USSR's Murmansk Oblast.

VIA NILS MATHISRUD

VIA NILS MATHISRUD

would select three "targets", e.g. a bridge, a railway station and a power station. General navigation was planned with a 1/500,000 map, while the detailed "photo-run" was planned on 1/50,000 or 1/100,000 maps.

Very precise navigation was needed to get photos of the standard required. The photo-recce pilot also had to observe as many details about the target as possible while photographing. The observations would be written down in a report and sent back to the squadron by radio. There has always been good-natured rivalry between RNoAF units, and these challenging photo-sorties were used by Thunderflash pilots to substantiate their claim that "a recce pilot is a fighter pilot with brains".

The sorties were planned both as LO-LO-LO, i.e. low-level flying at about 150m (500ft) above ground level (agl) throughout, or as HI-LO-HI, in which the flight started with a climb to 9,000m (29,500ft) to exploit the jet engine's increased efficiency and range at altitude. At about 50 nautical miles (90km) from the first target, the Thunderflash would descend to 150m to avoid detection by enemy radar. With the photo-shoot completed, the pilot would then take the Thunderflash back up to about 11,000m (36,000ft) for the return to base.

The RF-84F was normally equipped with two 450 US gal external fuel tanks beneath the wings (seen being jettisoned **ABOVE**), thus enabling a fuel load of 6,000lit (1,585 US gal). By flying a HI-LO-HI profile, this typically allowed for a flight covering Rygge to Bodø at 10,000m (33,000ft), a descent to 150m towards Narvik, photo-shooting of the target and a climb to 12,000–14,000m (39,000–46,000ft) for the return to Rygge, with Ålborg in Denmark as an alternative airfield.

The RF-84F was in service at the height of the Cold War, thus making "hot scrambles"a frequent occurrence. These would involve identifying, intercepting and photographing Soviet naval vessels and aircraft along the entire Norwegian coastline. These sorties were always exciting, as we could never predict the potential reaction from our quarry.

Another exciting and popular task was the completion of tactical photo-recce sorties over Continental Europe, directed by Nato and codenamed Exercise *Brandy Bottle* by Southern Norway Defence Command. Deployments were undertaken roughly once a week by two Thunderflashes of No 717 Sqn, which departed on a Monday for a Nato air base. From there,

RF-84E-26-RE serial 51-17053, coded AZ-G, in the type's final colour scheme in RNoAF service, comprising camouflage upper surfaces, white codes and Aluminium-painted undersides. This aircraft is currently on display at the Norwegian Armed Forces Aircraft Collection at Gardermoen, north of Oslo. Artwork by NILS MATHISRUD/VINGTOR © 2021

VIA NILS MATHISRUD

ABOVE ***Thunderflash serial 52-7319, coded AZ-C, was originally operated by France's* Armée de l'Air*, and was acquired by the RNoAF in October 1963. It served with No 717 Sqn until November 1969, when it was withdrawn from service. Four former RNoAF examples survive today as museum exhibits in Norway, plus one nose section.***

they would perform a low-level tactical photo-recce sortie, before landing at a new base each time, returning to Rygge on Thursday or Friday. To comply with the codename, a bottle of brandy was brought back to the squadron's bar on the completion of every exercise!

"THE SMOOTHING IRON"

The Thunderjet was a popular aircraft with its pilots, but it was undoubtedly underpowered. The aircraft weighed about 11,500kg (25,300lb) with full fuel tanks, while the Wright J65-3 engine provided only 3,300kg (7,275lb) of thrust. The relative power-to-weight ratio gave rather weak acceleration during take-off, and your first departure with full fuel tanks was an exciting experience; the aircraft often used 2,100m (6,900ft) of the 2,400m (7,900ft) runway before lifting off. Our pilots quickly became accustomed to using most of the runway on departure, but it must have looked alarming to spectators to see the aircraft roaring down the runway with apparently little prospect of actually unsticking from it.

When we departed airfields where we knew we would attract attention, we made the most of this effect for fun, and delayed our rotation until the very last few metres of the runway. The RF-84F would then climb majestically from the airfield on its distinctive swept, anhedralled wings, with its wide-track undercarriage legs hanging, sneaking over the nearest hill. Worry would creep over the spectators as the runway appeared to get shorter, while the pilot sat with a grin under his oxygen mask.

This characteristic take-off gave the Thunderflash its nickname — *Strykejernet* ("The Smoothing Iron") — and was the origin of many jokes about the type. One was about how we "fooled" the RF-84F into lifting from the runway. We would tell people that a sandbag was hung in the nosewheel bay, with a release cord to the cockpit. When the aircraft approached the end of the runway, the pilot pulled the cord to release the sand from the bag in front of the nosewheel. The aircraft would thus feel that it had exceeded the end of the runway and gracefully raise its nose and lift off.

Without external fuel tanks the RF-84F was a vigorous lady. We named this configuration the "GT" version, and it was a continuous fight between the pilots to fly these sorties, e.g. for aerobatics or supersonic dives. The early Republic jets represented the first generation of American supersonic fighters, but, to achieve the maximum speed of Mach 1·15, the pilot had to dive from about 12,000m (39,370ft) at full throttle. At low level the RF-84F was equivalent in performance to the F-86F and F-86K Sabres — but we could outrun them at high altitude.

The Thunderflash was a robust aircraft that could absorb a great deal of battle damage. One squadron pilot misjudged his altitude during a simulated missile attack against an infantry

REPUBLIC RF-84F THUNDERFLASH DATA

Powerplant 1 x Wright J65-W-3 turbojet of 7,300lb (3,310kg)-thrust or -W-7 of 7,800lb (3,540kg)-thrust

Dimensions		
Span	33ft 7in	(10·23m)
Length	47ft 8in	(14·52m)
Height	15ft 0in	(4·57m)
Wing area	325ft²	(30·19m²)
Weights		
Empty	14,014lb	(6,357kg)
Combat	20,091lb	(9,113kg)
Max take-off	25,390lb	(11,517kg)
Performance		
Max speed at sea level	679 m.p.h.	(1,093km/h)
Cruising speed	542 m.p.h.	(872km/h)
Landing speed	155 m.p.h.	(249km/h)
Climb	8,000ft/min	(2,400m/min)
Service ceiling	39,390ft	(12,006m)
Range normal	840 miles	(1,350km)
Range maximum	2,200 miles	(3,540km)

Armament 4 x 0·50in machine-guns

troop in Finnmark and effectively cut a swathe through a pine wood. The external fuel tanks were torn off, pine branches were stuck in the wings and jet intakes and the infantry soldiers were soaked in JP-4 fuel. Our colleague could smell burnt pine in the cockpit as the jetpipe temperature climbed. He headed towards the nearest airfield and sent an emergency message as he prepared to eject. The engine kept going, however, until he reached the airfield at Banak. Incredibly, the brake parachute worked, despite most of the compartment having been ripped off.

THREE THUNDEROUS YEARS

My final RF-84F flight was on October 17, 1969, in AZ-D, when I returned from a *Brandy Bottle* mission from Laarbruch in West Germany, together with 2nd Lt Thorstein Stenbek. We had been weatherbound in Germany for several days owing to fog. We approached Rygge late on

AUTHOR'S COLLECTION

ABOVE ***The author poses for a photograph beside a Thunderflash after a flight. He has been an active civil aerobatic pilot and flying instructor since 1970, and has written textbooks and training programmes for aerobatic pilots and instructors, as well as published numerous articles in aviation periodicals.***

Friday afternoon, but it too was fogbound, so we headed for Gardermoen and landed there in darkness. We parked the aircraft and continued by car to Rygge. With the conclusion of this flight, my time as a Thunderflash pilot was over. I accumulated 826 flying hours during my RF-84F period from August 3, 1966 to October 17, 1969. For the pilots of No 717 Sqn (PR), the cutting-edge Northrop RF-5A awaited us.

ACKNOWLEDGMENTS *The author and Editor would like to thank Norwegian aviation historian Nils Mathisrud of Vingtor Decals (www.vingtor.net) for his invaluable assistance with the preparation of this article*

BELOW ***Two generations of photo-reconnaissance specialists together in January 1969 — nearest the camera is RF-84F serial 52-8714, coded AZ-F, beside Northrop RF-5A serial 68-9105, AZ-M. The much more capable twin-engined RF-5A took over the RF-84F's role completely when the last RNoAF Thunderflash was retired in June 1970.***

VIA NILS MATHISRUD

EL LAPIZ

VOL. II.—N° 82.

DATOS CURIOSOS, APUNTES DE CARTERA, MISCELANEAS

REDACTOR: TULIO FEBRES CORDERO

FUNDADO EN 1885

EL LAPIZ

Mérida (Venezuela), octubre 16 de 1890.

Un mono aereonauta.—No sólo los hombres dan sus paseítos por la región de las nubes. En la mañana del 5 de octubre se elevó un globo de tela y de regulares dimensiones en la plazuela del Llano, parroquia urbana de Mérida, é iba en él un mono que á mucha altura, pero siempre á la vista, atravezó gran parte de la ciudad. El globo, al fin, fué descendiendo y hubo de caer sobre un árbol en las márgenes del Albarregas, donde se incendió inmediatamente; pero el mono, que iba suspendido por cuerdas de conveniente longitud, tan luégo como tocó en el árbol puso piés en polvorosa, salvándose así de la conflagración que le venía encima. A poco fué conducido en triunfo á la ciudad en medio de una turba de muchachos que le aclamaban héroe de la jornada.

El domingo 12 del corriente mes hizo su segunda ascensión, y aunque el globo empezo á incendiarse en el aire, nuestro simio aereonauta vino abajo sin daño alguno.

El darwinismo parece ser una idea innata, á juzgar por la costumbre general y constante de querer que los monos por fuerza ó de grado se asemejen al hombre en sus acciones y movimientos. ¡Ya se les despacha en globo para las nubes!

VENEZUELA'S AERONAUT MONKEY

Is it a bird? Is it a 'plane? No, it's a monkey strapped to a balloon in 19th-century Venezuela. **DR BERNARDO URBANI** of the Center for Anthropology at the Venezuelan Institute for Scientific Research investigates an intriguing report in a local newspaper in October 1890, which appears to offer evidence of the first (fiery) flight of a non-human primate in the Americas

ON OCTOBER 5, 1890, a monkey was attached, by an unknown experimenter or experimenters, to cords hanging from a cloth balloon, which then flew over the city of Mérida in the Venezuelan Andes, located at an elevation of 1,630m (5,350ft) above sea level. The monkey flew "at high altitude" from the Plaza El Llano to the neighbouring Albarregas River over a likely straight distance of around 150m (490ft). On October 12, a second flight reportedly took place. In both attempts, the balloons caught fire and fell to earth. Happily, the monkey survived and was acclaimed a "hero" by those who witnessed the flights.

Both events were reported in an article entitled *Un mono aereonauta* ("An Aeronaut Monkey"), published on October 16, 1890, in *El Lápiz*, a local magazine founded and written by Tulio Febres-

Cordero (1860–1938), a prominent *fin-de-siècle* Venezuelan scholar. At the time, evolutionist ideas were in vogue in Venezuelan academic circles, and Febres-Cordero was part of this intellectual milieu. As a curious final remark in his article, he pointed out that "Darwinism seems to be an innate idea, judging by the general and constant habit of wanting monkeys, by force or by degree, to resemble a man in his actions and movements. [Now] they have been despatched in a balloon into the clouds!"

In the forests surrounding Mérida, four species of monkey are found: variegated spider monkeys (*Ateles hybridus*); Andean night monkeys (*Aotus lemurinus*); ursine howler monkeys (*Alouatta arctoidea*) and white-fronted capuchins (*Cebus leucocephalus*). The latter is potentially the most plausible primate species that took part in these flights, based on the author's observation of capuchin monkeys as pets in Venezuelan Andean towns.

The first confirmed balloon flight with terrestrial animals occurred in 1783. Later, a primate "who has seen the world", known as the "celebrated monkey Jacopo, who will descend in a parachute", was an attraction at the UK's Surrey Zoological Gardens in 1835. To the best of my knowledge, the reports from Mérida cover the first events of non-human primate flights in the Americas, although there appears to be no other reference to these historical flights in Venezuela. If any *TAH* readers have any further information on the case reported here, or other early cases of non-human primate flight in South America, please contact the Editor.

In July 1901, a decade after the events in Mérida, a very short report, entitled *The Monkey Aeronaut*, was published in the *Aurora Daily Express* of Illinois in the USA, which describes "a veritable 'missing link', who with human instinct and intelligence, ascends in a balloon and jumps from it with a parachute", probably actually referring to Jacopo in 1835. This was the whole text, with no further contextual information. Next to this note, another is presented on experiments on capuchin monkeys conducted by American psychologist Edward Lee Thorndike (1874–1949), although this item has no apparent relationship with the previous one.

Nearly 60 years after the original Mérida report, rhesus monkeys were launched aboard V2 rockets into the atmosphere in the USA in 1948. In 1954 three monkeys reached an altitude of around 30km (98,000ft) using an experimental unmanned balloon launched in Michigan. The first suborbital capuchin monkey reached space under the auspices of the Argentinian space programme in 1969 — a far cry from the no-doubt-terrified Mérida monkey of 1890.

ABOVE ***Perhaps following in the giant steps that may have been taken by one of his primate ancestors in Venezuela in 1890, chimpanzee Ham (July 1957—January 19, 1983) became the first non-human hominid launched into space when he flew a suborbital flight on the Mercury-Redstone 2 mission on January 31, 1961, as part of the USA's Project Mercury space programme.***

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Pan Am's "Rogue" Atlantic Clippers

Unravelling the names of Pan Am's Atlantic Division Lockheed Constellations, 1946

In early 1946 Pan American's Atlantic Division made the unilateral decision to embellish the *Clipper* title given to its new fleet of Constellations with the names of destinations the aircraft were to serve, leading to much confusion about the Division's "rogue" geographical *Clippers*. Using contemporary documents, **GREG SMITH** examines an intriguing puzzle

AUTHOR'S COLLECTION

Delivered to Pan Am on March 1, 1946, NC88846 (c/n 2046) is seen here at La Guardia in March or April of that year, still just named* Clipper*, although by May it would have the name* Clipper Bermuda *on its nose. This aircraft flew its first transatlantic service from New York to Hurn on April 20. Sadly, it crashed as* Clipper Great Republic *in Liberia during a Johannesburg—New York flight in June 1951, killing all aboard.

FROM 1945 TO 1955 Pan American Airways (PAA) was one of the world's largest commercial operators of the supremely elegant Lockheed Constellation, owning or operating a total of 41 examples during the type's career with the airline. A small part of the PAA Constellation story, and the subject of this article, is the early naming of the carrier's Constellation *Clippers*, specifically those of the airline's Atlantic Division. While PAA had famously given such monikers to aircraft before the Constellation entered service — the Martin 130 *China Clipper* and Boeing 314 *Yankee Clipper* for example — it was with the Constellation that PAA established the tradition of naming its aircraft after the famous Clipper sailing ships of the 1800s, following an executive decision to do so systemwide was made by PAA President Juan Trippe in late May 1946. The decision also clearly demonstrated that PAA's three distinct corporate divisions — Atlantic, Pacific and Latin America — did not always see eye-to-eye. Before Trippe's intervention, the Atlantic Division had unilaterally decided to name its Constellations after geographical locations, to which the Pacific Division objected. Hopefully this article will be a good step towards documenting and clarifying this brief, unique, often misunderstood and frequently overlooked slice of PAA's history.

In the beginning . . .

PAA was the second airline to receive the Model 049 Constellation, following TWA's initial allotment of the first ten off the assembly line. Neither TWA nor PAA took delivery of former USAAF C-69s; all were factory-fresh 049s delivered direct from Lockheed. (TWA would later purchase and convert several former C-69s; PAA never did so.) PAA's Constellations were delivered to both the Pacific and Atlantic Divisions from January 5, 1946, while the Latin America Division did not receive any that year. Initially, only the name *Clipper* appeared on the nose of PAA's Connies.

In late 1945 the Atlantic Division launched a "Name the Clippers" competition, open to all Atlantic Division employees. The deadline was December 1 that year and the prize was a $25 war bond. On January 15, 1946, the Pacific Division sent an internal memo to PAA's Director of Public Relations in New York, objecting to any potential name changes, referring specifically to the Atlantic Division's competition, stating: "We were under the opinion [sic] that the decision had been made on a system basis to standardise the paint job on the front of each aircraft with the word *Clipper* appearing alone". The Pacific Division was in favour of referring to the aircraft simply as a "Pan American *Clipper*" rather than as, say, "Pan American's *Honolulu Clipper*". The Pacific Division thus opined that "confusion can be eliminated and the acceptance of the name *Clipper* can be accelerated".

Meanwhile, in early February 1946, the Atlantic Division watched as TWA made inaugural flights to Europe with aircraft publicly christened *Star of Paris, Star of Rome, Star of Madrid* and *Star of Cairo*. To add insult to injury, the February 11, 1946, cover of American magazine *Aviation News* featured a prominent picture of TWA Constellation *Star of Paris*. This was the last straw for PAA's Atlantic Division. Transatlantic competition with TWA was starting to heat up, and

OPPOSITE PAGE ***Constellation NC88832 was delivered to Pan Am in February 1946. It is seen here with just the name* Clipper*, as per standard procedure at the time, on the forward fuselage below the cockpit, before it was allocated to the airline's Pacific Division, although it would return to the Atlantic Division as* Clipper Flora Temple.**

AUTHOR'S COLLECTION

ABOVE ***This promotional item from Pan Am incorporates a photograph of passengers boarding NC88836 (c/n 2036),*** **Clipper England.** ***This aircraft is mentioned in the Marine & Aviation Reports in early May 1946, but is absent during May 27–July 3, for unknown reasons — perhaps the aircraft underwent an extended period of maintenance.***

PAA's Atlantic Division would respond in kind.

The Pan American World Airways Special Collections, held by the library of the University of Miami, contain numerous interesting internal memos regarding PAA's aircraft names, some of which are specific to the Constellation fleet. One very thorough memo was drafted by advertising consultancy J. Walter Thompson, hired to research possible PAA aircraft-naming conventions. Dated April 8, 1946, and addressed to Juan Trippe, it evaluates several nomenclature options. The concept of *Clipper* names based on the original merchant sailing vessels was recommended as the most desirable system. Several examples of the names of the original sailing boats are given, including *Clippers Lightning, Morning Light, Boston Light, Guiding Star, Meteor, Starlight, Southern Cross* and others. A comment has been handwritten on the memo beside *Guiding Star*, pointing out that TWA was using the name "Star". Again, it shows the fierce competition brewing between the two airlines and the reason why no PAA Constellation *Clipper* name ever contained the word "Star".

On April 11, 1946, the Atlantic Division made an announcement naming its *Clipper* Constellations after geographical locations. For the first time, the word *Clipper* would precede the name. The announcement was made less than two weeks after TWA had issued its *"Star of . . ."* Executive Bulletin naming all of its Constellations after foreign cities or destinations along TWA routes. Now TWA's *Star of Dublin* would compete with PAA's *Clipper Dublin*.

A PAA update was posted on May 9, 1946, with specific Constellation aircraft assignments, noting that "11 Constellations flown by the Atlantic Division are flaunting new names as they take off for England, Ireland, Portugal, Bermuda and the Belgian Congo". The *Clipper* names were as follows: *London, England, Shannon, Eire, Dublin, Bermuda, Congo, Lisbon, Portugal, Africa* and *America.* It also mentioned that *Clippers Brussels* and *Vienna* were to be added after June 1.

The pressure of publicity

From May 7 to October 15, 1946, the *New York Times* listed international airline arrivals and departures from La Guardia Airport (known as Marine & Aviation Reports) using individual aircraft names, the newspaper having previously

When the Constellation joined the Pan Am fleet in February 1946, the elegant propliner was painted in a stylish colour scheme, predominantly bare metal with dark blue cheatlines running the length of the cabin, the legend Pan American World Airways on the fuselage and "PAA" titles in blue stripes on the outer fins. This example, NC86520 (c/n 2503), was one of three Connies to use the name **Clipper America,** ***although not the one originally used by the Atlantic Division in 1946. Artwork by JUANITA FRANZI © 2021***

"Curiously, the name *Clipper London* was already being used at that point by Constellation NC88831, which also served London, so PAA briefly had two concurrent Constellation *Clipper Londons* serving the British capital . . ."

AUTHOR'S COLLECTION

ABOVE ***It appears that two Constellations bore the name* Clipper London *— NC88860, if only for a few days, and NC88831, the latter seen here with the name clearly visible on the nose. According to Peter Marson's definitive two-volume monograph on the Constellation (Air-Britain, 2007), this aircraft was originally named* UNO Clipper.**

listed the arrival and departure of large passenger ships. (The individual names were no longer published after October 15.) This appears to be the motivation of PAA's Atlantic Division to name its aircraft in the aforementioned April 11 and May 9 announcements. The *New York Times* probably asked for the names of the PAA aircraft, noting that TWA and American Overseas Airlines (AOA) would be supplying theirs. The Atlantic Division perhaps felt compelled to keep up with TWA and AOA, broke ranks with the other PAA Divisions and started independently naming its *Clipper* Constellations. Every Atlantic Division geographic *Clipper* name may be found in these reports between May 7 to July 12, 1946, with the exception of *Clipper New York* (used on an unscheduled survey flight during that time) and *Clipper Brussels* (probably never used).

Of note in the listings is the addition of geographic *Clipper* names not included in the May 9 announcement — *Clippers Europe, Courier* and *Atlantic*. Here we will look into these "mystery Clippers" to try to piece together their identities and back-stories.

NC88860 – chameleon Clipper

There appears to be very little photographic and documentary evidence relating to a *Clipper Europe* in the Atlantic Division's in-house *Clipper* newspaper, any mainstream news feature or in the University of Miami archive material. Yet a PAA *Clipper Europe* was flying in and out of New York for 38 days of those listed in the Marine & Aviation Reports. During May 15–22 only one Atlantic Division Constellation is unaccounted for — NC88860. So, by default, it would appear that NC88860 (c/n 2060), fleet number "60", was initially named *Clipper Europe*.

According to the May 9 announcement, the next prospective names for the PAA Constellation fleet were *Clippers Brussels* and *Vienna*, but only after June 1. However, NC88860 was delivered to PAA on May 1. British airline historian and *TAH* contributor Peter J. Marson has provided a pre-delivery picture of NC88860 still at the Lockheed factory at Burbank, with just the word *Clipper* on the nose. It remains unclear whether this aircraft was delivered to PAA with *Clipper Europe* on its nose or if it was applied subsequently by PAA's Atlantic Division, before being put into service on May 15. The reason why the name *Clipper Europe* was selected in lieu of *Vienna* or *Brussels* may have been connected with the "Name the Clipper" competition, about which more later.

During May 23–28, 1946, NC88860 was used for a survey flight to Syria, and the name *Clipper Europe* was evidently removed. In an article entitled *The Road to Damascus* in the June 13, 1946, issue of the Atlantic Division's *Clipper* newspaper, a single photograph of the aircraft appears with the name *Clipper New York* (with "860" on the nose door), and the aircraft is referred to as such in the article. This would make it the only Atlantic Division *Clipper* Constellation to wear the name of an American city. On completion of 860's Syrian survey work, it was swiftly enlisted for another special and much-publicised flight, becoming the first PAA aircraft to land at the new London Airport, on May 31, 1946, by this time wearing the name *Clipper London*. The name *Clipper New York* was never used again on any aircraft.

Curiously, the name *Clipper London* was already being used at that point by Constellation NC88831 (c/n 2031), fleet number "31", which also served London, so PAA briefly had two concurrent Constellation *Clipper Londons* serving

AUTHOR'S COLLECTION

ABOVE ***Definitive photographic evidence that NC88860 bore the name* Clipper London *is provided in this image of the aircraft — note the "860" on the nosewheel door — at London Airport on a typically drizzly day in 1946. This "chameleon" Connie changed its name regularly in 1946, and made the first Pan Am flight into Heathrow on May 31.***

the British capital. Numerous photographs were taken of the inaugural flight to London Airport and NC88860 is often referred to as the definitive *Clipper London*, despite carrying the name for only about two days.

In the two-week period following NC88860's arrival in the UK as *Clipper London*, things become even more murky. Was this aircraft briefly named *Clipper Vienna*? It is unlikely; Peter Marson has conducted an exhaustive search of PAA *Clipper* names and found no connection between fleet number "60" and *Clipper Vienna*. Did the aircraft re-emerge as the mysterious *Clipper Europe*? Peter thinks so, as he explains: "There is strong evidence that this aircraft alternated between *Clipper London* and *Clipper Europe* and may even have been renamed the latter in London for the inaugural return flight to the USA. *Clipper Europe* is reported in the *New York Times* Marine & Aviation Reports, each time tying in with records of NC88860 (May 15 and June 1 and 18, 1946)".

A check of the Marine & Aviation Reports reveals that a *Clipper Europe* was flying to and from London during June 1–11, making a total of 11 round trips. As we shall see, this chameleon *Clipper* had not finished changing names; it would take on a new moniker three more times during June and July 1946.

Atlantic and Shannon/Vienna

As previously mentioned, the next prospective geographical *Clipper* names were *Brussels* and *Vienna*. It seems likely that *Clipper Brussels* never materialised. The first reference to a *Clipper Atlantic* appears in the Marine & Aviation Reports for May 19, 1946, destination Bermuda. Another mention of *Clipper Atlantic* is made in an article entitled *Getting the Bird*, dated June 13, 1946, which describes how the aircraft had been delayed by the removal of "one dead black crow" from an engine.

Exactly why Constellation NC88861 (c/n 2061), fleet number "61", was named *Clipper Atlantic* rather than *Vienna* or *Brussels* remains a mystery, but it may be that by the time "61" was delivered to the Atlantic Division on May 9, 1946, the latter may have been aware of the forthcoming decision to name all four-engined PAA aircraft after famous Clipper sailing ships systemwide. Was this an act of defiance or pride? It is only speculation, but it may not be a coincidence that the Atlantic Division snuck in the name *Clipper Atlantic* before PAA's official announcement.

So it was that on May 22, 1946, the Executive Vice-President of PAA issued a memo, approved by Juan Trippe, that all PAA four-engined aircraft would be named after historic sailing Clipper ships, 41 days after the Atlantic Division had announced the naming of all Constellation *Clippers* after geographical locations.

One of the more camera-shy Constellation *Clippers* was NC88837 (c/n 2037), fleet number "37", which apparently served as both *Clipper Shannon* and *Clipper Vienna*. This aircraft is listed in the Marine & Aviation Reports in early May 1946 as flying to and from Bermuda as *Shannon*. The aircraft then disappears from the listings until June 17. Curiously, it is not featured in PAA's mid-1946 promotional film *Wings to Ireland*, despite its obvious relevance; instead, *Clippers*

VIA PETER J. MARSON

ABOVE *Constellation NC88861* Clipper Atlantic *is something of an anomaly in the Atlantic Division fleet in that it was delivered in mid-May 1946 and not given a geographical name, made all the more odd by the fact that the Division had stated that the next two names would be* Brussels *and* Vienna*. It is seen here at Heathrow in 1946.*

Portugal (NC88856, c/n 2056, "56") and *Congo* (NC88850, c/n 2050, "50") are the recognisable stars of the film.

The reason for this disappearance of *Clipper Shannon* appears to be that NC88837's name was temporarily changed. During June 4–16, a *Clipper Vienna* is listed as flying the long-haul route to and from Leopoldville in the Belgian Congo. Peter Marson notes that "NC88837 was recorded as *Clipper Vienna* several times during June 4–16 only". So why the name change? Was this aircraft intended to earn the distinction of flying the inaugural flight to Vienna on June 15? Ultimately it did not, NC88860 being bestowed with that honour, albeit with yet another *Clipper* name, of which more shortly.

From June 17 NC88837 apparently reverted to the name *Clipper Shannon*. No photographic evidence of this aircraft as either *Clipper Shannon* or *Clipper Vienna* has yet come to light. *[Do any readers have anything? — Ed.]* This aircraft is listed on 38 days of the Marine & Aviation Reports, either as *Clipper Shannon* (32 days) or *Clipper Vienna* (six days). It would be less camera-shy after August 1946, when it became *Clipper Challenge*.

Less than a month after the issuing of the PAA Executive memo to rename the *Clippers*, the Pacific Division was already renaming its four-engined aircraft as per the list of original Clipper sailing ships. The seven newly named Pacific Division *Clipper* Constellations were:

- NC88832 (c/n 2032), *Clipper Golden West*;
- NC88833 (c/n 2033), *Clipper Polynesia*;
- NC88847 (c/n 2047), *Clipper Southern Cross*;
- NC88848 (c/n 2048), *Clipper Golden Gate*;
- NC88859 (c/n 2059), *Clipper Resolute*;
- NC88865 (c/n 2066), *Clipper Racer*;
- NC88868 (c/n 2067), *Clipper Peerless*.

The June 15, 1946, edition of the Pacific-Alaska Division *Clipper* newspaper prominently features *Southern Cross* in an item covering the announcement. It would be more than a month, coupled with an aviation tragedy, before the Atlantic Division would make a similar one.

The speed at which the Pacific Division renamed its aircraft is somewhat redolent of sibling rivalry, with the obedient Pacific Division complying with the systemwide naming rules swiftly, while the rogue Atlantic Division scratches its head and procrastinates. Ironically, six of the seven Pacific Division Constellations would be transferred to the Atlantic Division by February 1947 and would have their *Clipper* names changed again, in line with those assigned to the Atlantic Division. An internal memo from the Pacific Division, dated January 16, 1947, requests the Atlantic Division to cease using the Pacific Division's names of the transferred Constellations, so that the Pacific Division may reassign them.

The chameleon Clipper – again

As mentioned, Constellation "60" was named *Clipper Europe, New York, London* and then *Europe* again, all within a 28-day period. Then, in the June 19, 1946, edition of the *New York Times*, an article covering the inaugural PAA flight to Vienna on June 15 prominently shows aircraft "60" clearly named as *Clipper Courier*.

Once again, it may be necessary to speculate on timings and what the historical visual record

AUTHOR'S COLLECTION

LEFT ***Another week, another name — NC88860, clearly bearing the name*** **Clipper Courier*****, arrives to great fanfare at Prague in Czechoslovakia, probably on June 17, 1946, when the aircraft flew the first Clipper air mail flight from Prague to Limerick in Ireland.***

BELOW ***Minus its No 4 Wright R-3350 engine, NC88858*** **Clipper America** ***sits on its belly at Willimantic, Connecticut, on June 18, 1946. It was patched up with a strip of sheet metal riveted over the leading edge in place of the engine and returned to Burbank for repairs.***

shows. The Pacific Division announced the renaming of its Constellations with the names of historic Clipper ships on June 15, 1946, and the fact that the Atlantic Division had sent a freshly named *Clipper London* (not a Clipper ship name) to London for a highly publicised event on May 31 may have ruffled some PAA executive feathers.

Clearly, the logical name for the inaugural flight to Vienna on June 15 would have been *Clipper Vienna*. The Marine & Aviation Reports list a *Clipper Vienna* operating into and out of La Guardia from June 4, which has been identified as referring to NC88837. The timing of the latter's name change to *Clipper Vienna*, and the fact it resumed the name *Clipper Shannon* from June 17, appears to confirm this identification. It is possible that a high-level telephone call in early June, perhaps from Trippe himself, was made, specifying that the upcoming Atlantic Division inaugural flight to Vienna was not to feature a geographical name, but rather a name from the list of historic Clipper ships assigned to the Atlantic Division. Trippe was a passenger on this inaugural flight, the aircraft being named after the old *Clipper Courier* sailing ship. Much of this is speculation based on the available facts, but what is known is that by June 15 both the Pacific and Atlantic Divisions had started naming their Connies after Clipper ships. Therefore, "60" may be historically recognised as the first Atlantic Division aircraft to be named after a sailing ship.

Amazingly, *Clipper Courier* disappears from the Marine & Aviation reports just three days after the inaugural flight to Vienna, and *Clipper Europe* returns — an apparent act of deliberate defiance. The May 22 executive memo approved by Juan Trippe, specifying that all four-engined aircraft were to be given the names of historic sailing clippers, was quite clear: "Will you kindly request the Divisions under your jurisdiction to carry out this program at the earliest practicable time?". The Atlantic Division complied with the memo with one aircraft for three days.

Two significant events, however, occurring on June 18 and July 11, 1946, forced the Atlantic Division to rename the entire geographically named Constellation *Clipper* fleet, as per the instructions of the May 22 memo.

Clipper America down

The most infamous Atlantic Division geographical *Clipper* Connie was NC88858 (c/n 2058), *Clipper America*. On June 18, 1946, during a New York–London flight, the aircraft's No 4 engine separated from the wing. The pilot set the aircraft down with the undercarriage retracted at a small airfield in Willimantic, Connecticut. The flight was returning the Old Vic Company to the UK, with Laurence Olivier and his wife Vivien Leigh aboard. The aircraft was swiftly patched up to fly

AUTHOR'S COLLECTION

DAVID H. STRINGER COLLECTION

ABOVE ***Another splendid promotional item from Pan Am's publicity department. This excerpt from a September 1946 timetable, using the same photo of* Clipper England*, runs through the itinerary of an imaginary businessman visiting the UK, with a trip to the Tower of London, a rustic country village and a day at the seaside in Shannon.***

with three engines and flown to Long Island and then Burbank to be repaired. It would fly again in PAA service as *Clipper Empress of the Skies*, which crashed on landing at Shannon in April 1948.

The name *Clipper America* was used on two other PAA Constellations — L-749s NC86520 and NC86530 — as well as other later types. This was one geographical *Clipper* name that PAA evidently did not mind retaining; Airbus A300 N202PA was carrying the name when PAA ceased operations in 1991.

On July 10, 1946, NC88845 *Clipper Dublin* and NC88860 *Clipper Europe* departed New York for Bermuda at 1000hr and 1400hr respectively. Interestingly, the following day, the two *Clippers* listed as "Departed Yesterday" for Bermuda are *Clipper Dublin* and *Clipper Courier* at 1000hr and 1600hr respectively — another clue that NC88860 was both *Clipper Europe* and *Clipper Courier*. The two-hour flight delay may have been the time needed for the experienced PAA paint crew to change the aircraft's name. Thus NC88860 became the second Atlantic Division aircraft to be named after a Clipper sailing ship — both times as *Clipper Courier*. No announcement of impending name changes

AUTHOR'S COLLECTION

ABOVE ***Constellation NC88850 (c/n 2050),* Clipper Congo, *is listed in the* New York Times' *Marine & Aviation Reports as being at La Guardia on 46 days of the published listings, cycling through various destinations as far afield as Bermuda, London, Lisbon, Dakar in French West Africa and of course Leopoldville in the Belgian Congo.***

had yet been made by the Atlantic Division.

On July 11, 1946, TWA Constellation NC86513 (c/n 2040), *Star of Lisbon Sky Chief*, crashed on an instrument training flight. Shortly after departing Reading Airport, Pennsylvania, smoke started to fill the interior of the aircraft, including the cockpit. With limited visibility and increasing intensity of smoke and heat, the captain attempted to return the aircraft to Reading for an emergency landing. Two miles (3km) north-west of the airport, the aircraft struck electrical power cables and crashed. The following day the Civil Aeronautics Administration grounded all Constellations for 30 days. The recent forced landing of *Clipper America* and a USAAF C-69 crash the previous year also weighed in to the decision to ground the type.

The Marine & Aviation Reports for July 9, 1946, three days before all Connies were grounded, list all 12 of PAA's geographical *Clippers*, the only date that this ever happened, and confirms that NC88860 was indeed *Clipper Europe*. It also clearly shows that the Atlantic Division was in no rush to rename its geographical *Clipper*s.

A photograph taken immediately after the grounding shows four PAA Constellations lined up at La Guardia, depicting NC88845, clearly still named *Clipper Dublin* (soon to be renamed *Clipper Eclipse*); the Pacific Division's NC88868 *Clipper Peerless* (officially transferred to the Atlantic Division in January 1947); NC88850, still *Clipper Congo* (soon to be renamed *Clipper Intrepid*) and NC88861, which is probably still named *Clipper Atlantic* (later *Clipper Winged Arrow*), although the name is not legible in the photograph.

Atlantic drags its heels

Although it would be tempting to assume that these name changes were an attempt to sanitise the image of the grounded Connies, introducing a fresh naming convention based on the historic Clipper sailing ships, this is incorrect. The July 24, 1946, edition of the Atlantic Division *Clipper* newspaper declared both the name changes of the Atlantic *Clipper* Constellations *and* the grounding announcement of all Constellations, thus countering the assumption that the grounding precipitated the name changes. Both announcements were made prominently on the front page. The internal PAA memo from April 8, 1946, regarding the consultancy work of J. Walter Thompson, clearly shows that this action

BELOW ***Four Pan Am Constellations at La Guardia following the type's grounding in the wake of a series of accidents during 1945–46. Photographs of the Atlantic Division's "rogue" Constellations with geographical names in 1946 are scarce, so if any readers have any in their collections, please do contact the Editor and let us know!***

AUTHOR'S COLLECTION

was already moving forward, some 107 days before the Constellations were grounded. The Pacific Division had already begun assigning and renaming its Constellations by June 15. Furthermore, the fact that the Atlantic Division fielded NC88860 as *Clipper Courier* 35 days before the grounding of the type shows that the former at least toyed with complying with the executive decision of May 22. As we know, the day before the Constellations were grounded, NC88860 became *Clipper Courier* again. The Atlantic Division was inching towards complying with the name changes, even if rather reluctantly.

Also of note is the winning entry in the "Name the Clipper" competition — *European Clipper* — which may have had some influence on why NC88860 was named *Clipper Europe*. I am always hopeful that a photograph of the winner standing in front of *Clipper Europe*, proudly displaying the $25 war-bond prize, will materialise; it may be in a dusty family album somewhere.

The grounding of the Constellation was an opportunity for PAA's executive leadership to impose its will. A July 24 announcement in the newspaper *Clipper* states: "The new systemwide policy for naming *Clippers* was adopted and the matter taken out of the Division's hands". Thus, before the grounding, the Atlantic Division had not fully adopted the renaming of its Constellation *Clippers* — just one of 13 — but all would be renamed as per sailing ships when they were returned to service in September 1946.

On July 31, 1946, the Atlantic Division published an initial list of historic Clipper ship names to be associated with each Constellation (see panel at right; some of these would change the following month). *Clipper Peerless* is listed with the Pacific Division name, yet it would become *Clipper Golden Fleece* after it was officially transferred to the Atlantic Division in January 1947.

Conclusion

I wrote this article because the Atlantic Division's "rogue" geographic Clippers are in danger of being lost to history. The photographic record is sparse and still incomplete, but there is a clear case that they did indeed exist; we have explored why they did, and why they had disappeared by September 1946. However, the history of PAA's naming convention for the Constellations does not end in September 1946; rather, it just begins. The Constellation would serve PAA for another decade, with Divisional transfers, the renaming of aircraft owing to displacement, leased aircraft, inaugural services and mergers, all resulting in new *Clipper* names for the fleet, all of which are outside the remit of this article.

And what of our chameleon Clipper, NC88860? This aircraft was sold to PAA subsidiary Panair do Brasil on May 24, 1947. Having originated with the pre-delivery name *Clipper*, NC88860 went on to be named *Europe* three times (possibly four), *New York* once, *London* once and *Courier* twice in PAA service, before becoming *Domingos Barbosa Calheiros* with Panair do Brasil — a total of nine name changes in 392 days!

Pan Am's Atlantic Division Constellations, 1946

THE DAILY MARINE & Aviation Reports in the *New York Times* between May 7 and October 15, 1946, listing the names of aircraft departing La Guardia Airport, have made documenting the 1946 PAA Atlantic Division geographic *Clipper* names possible. The table below quantifies the number of days each Constellation *Clipper* name appears in the Reports:

Registration	Geographic *Clipper* name	Days reported
NC88831	*Clipper London*	37
NC88836	*Clipper England*	19
NC88837	*Clipper Shannon*	32
	Clipper Vienna	6
NC88838	*Clipper Eire*	19
NC88845	*Clipper Dublin*	45
NC88846	*Clipper Bermuda*	40
NC88850	*Clipper Congo*	46
NC88855	*Clipper Lisbon*	47
NC88856	*Clipper Portugal*	42
NC88857	*Clipper Africa*	53
NC88858	*Clipper America*	33
NC88860	*Clipper New York*	0
	Clipper London	2
	Clipper Europe	38
	Clipper Courier	4
NC88861	*Clipper Atlantic*	44
NC88868*	"68"	2

* Clipper "68" was a Pacific Division Constellation which retained the name *Clipper Peerless* until transferred to the Atlantic Division in 1947

In late July 1946 Pan Am published the list of *Clipper* names for the Atlantic Division that would be used on the type's return to service after grounding earlier that month in the wake of a spate of Constellation accidents. These were:

Registration	Original sailing-ship *Clipper* name
NC88831	*Clipper Carib*
NC88836	*Clipper Carrington*
NC88837	*Clipper Challenge*
NC88838	*Clipper Donald McKay*
NC88845	*Clipper Eclipse*
NC88846	*Clipper Great Republic*
NC88850	*Clipper Intrepid*
NC88855	*Clipper Invincible*
NC88856	*Clipper Paul Jones*
NC88857	*Clipper Undaunted*
NC88858	*Clipper Empress of the Skies*
NC88860	*Clipper Courier*
NC88861	*Clipper Winged Arrow*
NC88868	*Clipper Peerless*

TURKISH DISMAY

THE ILL-STARRED ROHRBACH Ro IX ROFIX FIGHTER

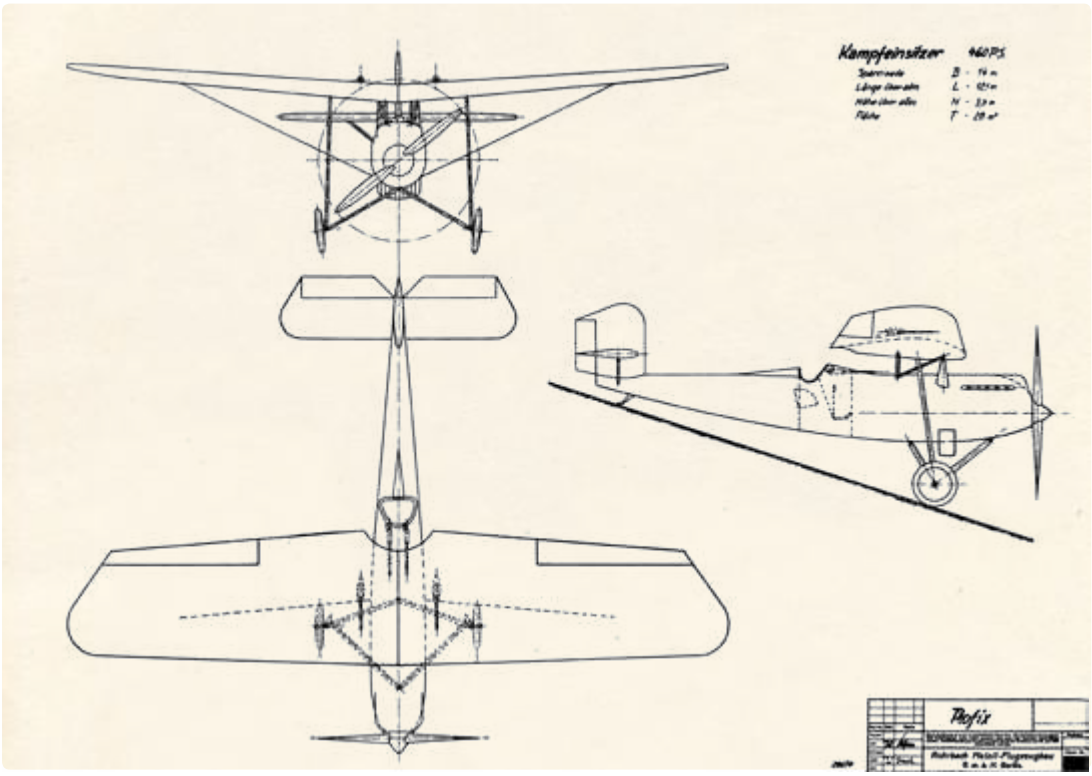
Although less well-known than his fellow German aircraft designers, Adolf Rohrbach was a pioneering early advocate of all-metal design. His Rofix parasol monoplane fighter of the mid-1920s, designed to a Turkish requirement, initially showed a great deal of promise, but the crash of both prototypes saw it fade into obscurity, as **LENNART ANDERSSON** explains

OWING TO THE restrictions on Germany's aviation industry, a consequence of the Versailles Treaty, which took effect in January 1920, several German aircraft companies established subsidiaries in Denmark, Italy, Sweden and Switzerland. Among them was the Rohrbach Metall-Flugzeugbau GmbH, founded by pioneering aircraft designer Adolf Rohrbach, who had realised before others that the future in aircraft design lay in metal, rather than wood and canvas. The company quickly grew to become one of the largest in Germany, and the Rohrbach Metal Aeroplan Co A/S in Copenhagen took care of the assembly and testing of the company's military types.

In July 1925 a Turkish delegation visited Copenhagen, and by the end of the year rumours were circulating in the press that Turkey had ordered 50 examples of a new fighter aircraft called the Rohrbach Rofix. The Spad S.XIII fighters of the Turkish Air Force needed replacing and an international tender had been announced. Submissions were received for the Dewoitine D.21, Nieuport-Delage NiD 42 and NiD 62, Spad S.51, S.56 and S.61, Junkers K 53 and the Rohrbach Rofix. Two examples each of the D.21, NiD 42, S.51 and Rofix were ordered for evaluation. A Junkers K 53 was also sent for trials the following year. The Rofix order was placed in March 1926 and the contract included an option for 28 more. Detail design and construction of the Ro IX Rofix started immediately in the parent factory in Berlin.

BELOW ***The second Rohrbach Rofix prototype, c/n 23, in Turkish markings at Kastrup in Copenhagen for the type's acceptance trials in July 1927. The Rofix was designed specifically to a Turkish requirement for a fighter to replace its ageing Spad S.XIII biplanes. The Turkish Navy also acquired two Rohrbach Ro IIIa Rodra flying-boats in 1926.***

FLYVERTROPPERNE VIA STEEN HARTOV



AUTHOR'S COLLECTION

The Rofix was a single-seat parasol monoplane fighter. The wing had a cut-out in the trailing edge over the cockpit and was mounted on the fuselage via cabane struts. A single bracing wire ran from each wing down to the bottom of the fuselage. The wing structure centred upon a box-girder mainspar that was typical of Rohrbach. The skin was strengthened by small riveted-on Duralumin profiles.

The fuselage was of oval section and the cockpit was located unusually far aft. The 12-cylinder liquid-cooled 500–750 h.p. BMW VI engine was covered by streamlined cowlings and the radiator was slung on the underside of the fuselage, in line with the wing's leading edge. Armament consisted of two fixed forward-firing 8mm (0·3in) machine-guns with 500 rounds; the guns could be mounted in the upper forward fuselage or in the wings.

FIRST FLIGHT

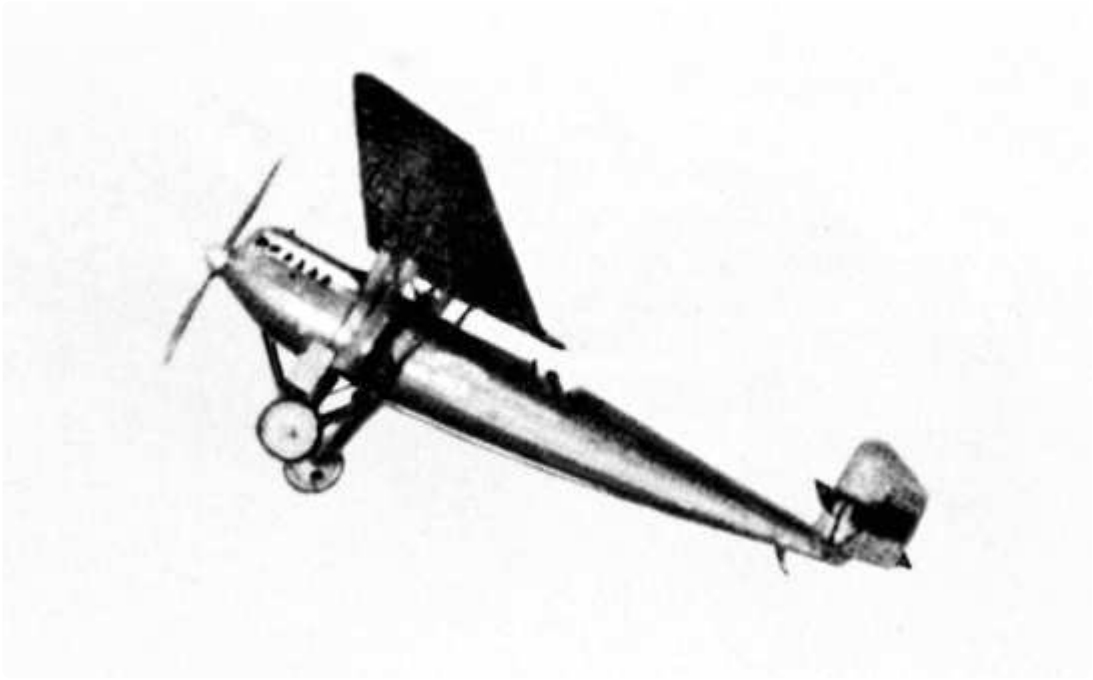
By August 1926 the two Rofixes were nearing completion and, on the 11th of the month, the Danish authorities granted a test-flight permit. In September a permit to fire from the air with machine-guns mounted on the Rofix was applied for. It is not known exactly when the maiden flight of the first example (c/n 22) took place, or who was at the controls, but it was probably Rohrbach's company pilot Werner Landmann. Early in his career, Landmann had set a world solo endurance record with a 21hr

ABOVE ***A company three-view of the Rofix dated May 15, 1926. The type's spinning characteristics caused some concern; the dihedral of the wings was altered several times to remedy the problem, and to address the fact that the Rofix was deemed too stable to offer the manœuvrability required in a fighter.***

ROHRBACH Ro IX ROFIX DATA

Powerplant 1 x liquid-cooled 500–750 h.p. BMW VI inline piston engine

Dimensions		
Span	14·0m	(45ft 11in)
Length	9·05m	(29ft 8in)
Height	3·7m	(12ft 2in)
Wing area	28m²	(301ft²)
Weights		
Empty	1,320kg	(2,910lb)
Loaded	1,850kg	(4,079lb)
Wing loading	66·1kg/m²	(13·54lb/ft²)
Power loading	4·1kg/h.p.	(9·04lb/h.p.)
Performance		
Maximum speed		
at sea level	257km/h	(160 m.p.h.)
at 3,000m (10,000ft)	285km/h	(177 m.p.h.)
Landing speed	105km/h	(65 m.p.h.)
Climb		
to 1,000m (3,300ft)	2min	
to 5,000m (16,500ft)	14min	
Ceiling		
absolute	8,000m	(26,000ft)
practical	7,600m	(25,000ft)



THEO WESSELINK COLLECTION VIA AUTHOR

ABOVE ***A rare photograph of the first prototype, c/n 22, during a demonstration flight. The Rofix was competing for the Turkish order with a number of French designs and the German Junkers K 53, a militarised version of the company's A 35, Turkey having established a relationship with Junkers with the acquisition of A 20s in 1925.***

THEO WESSELINK COLLECTION VIA AUTHOR

ABOVE ***Another photograph of the first prototype in flight, this time with pronounced wing dihedral. The aircraft appears to be painted in a single dark colour overall and have the legend "Rohrbach Rofix" applied to the fuselage forward of the cockpit. Note the BMW VI engine's unfaired radiator protruding from the underside of the fuselage.***

AUTHOR'S COLLECTION

ABOVE ***In 1927 internationally renowned aviator Ernst Udet, then working as a freelance pilot, made several trips to Copenhagen to participate in the Rofix's test-flying programme. He is seen here in the cockpit of the first prototype, the unpainted fuselage of which carries the legend*** **"DANSK PRØVELUFTFARTØJ"** ***(Danish Test Aircraft).***

49min non-stop flight made in June 1914. He became a military pilot after the outbreak of the First World War, was shot down over the Eastern Front and served time as a prisoner of war in Russia. In 1923 he joined Rohrbach.

On August 31, 1926, Rohrbach reported that c/n 22 was ready and that c/n 23 was almost complete, which seems to indicate that c/n 22 was probably first flown in early September. Apparently there were problems with the aircraft's spinning characteristics, and the prototype had to be modified several times with different degrees of wing dihedral. Otherwise, handling was described as excellent and landing characteristics were good. The aircraft was well suited for aerobatics, crucial for a fighter.

A MAJOR SETBACK

On January 27, 1927, disaster struck. Landmann was unable to stop a spin and crashed in the first prototype, which was wrecked beyond repair. Landmann was injured, but survived the crash.

While Landmann recovered, Joachim von Köppen arrived from the *Deutsche Versuchsanstalt für Luftfahrt* (DVL — German Aviation Test Establishment) to test the Rofix. A total of 28 flights had already been made, but it is not clear if this was with c/n 22 only, or with both prototype aircraft. Von Köppen made three flights in c/n 23 and according to his test report the Rofix was a good aeroplane. He stated:

"The good take-off and landing performance makes it possible to use the aircraft from confined areas. The aircraft does not in any flight attitude show any special problems or dangerous characteristics. It can be flown easily and safely by any average pilot. High speed and good climb performance are combined with good manœuvrability, which makes the aircraft very well suited for its purpose."

Despite the loss of the first example, the future of the Rofix looked promising. Probably after Landmann's crash, Ernst Udet was engaged to test-fly the Rofix. Udet had obtained a civilian pilot's licence in April 1915 and was accepted for service in the German Air Force. He first flew in an observation unit, but was later transferred to a fighter unit and shot down his first enemy aircraft in March 1916. His reputation as a successful fighter ace had earned him an invitation to join the elite *Jagdgeschwader 1* under the command of Manfred von Richthofen, the Red Baron. Eventually Udet became a national hero with 62 confirmed kills. In September 1918 he was wounded and was still recovering when the war ended in November. A few years later he established his own aircraft company, Udet Flugzeugbau, in Munich, but left the firm after a couple of years.

Udet travelled repeatedly to Copenhagen in the early summer of 1927, and he had probably flown the Rofix before von Köppen evaluated it. The dihedral of the wings had been changed as the aircraft was too stable laterally, and the original engine had been replaced by a 500–750 h.p. BMW VIa with Zenith carburettor and

The second Rofix prototype, c/n 23, in its Turkish markings and the legend "Rohrbach Rofix" displayed diagonally across the rear fuselage. Note the lack of dihedral on the wings. With the first prototype damaged beyond repair in January 1927, everything was riding on the success of the second in Turkish acceptance trials in July the same year. MATS AVERKVIST VIA AUTHOR

electron casing. On July 1, 1927, Udet wrote a report on his two most recent flights, stating that take-off and landing in the Ro IX was simple and easy. The pilot had a good field of view in all directions, even better than in the Fokker D VII. He also noted that the ailerons could be more effective and that the rudder was too small, but that the action of the elevators was good.

ENTER PAUL BÄUMER

On July 13 von Köppen reported that he had made another nine flights, and on that day another well-known First World War fighter pilot, Paul Bäumer, arrived in Copenhagen. During the war he had been accepted for military pilot training and by October 1916 he was serving as a ferry pilot and instructor. He was later trained to fly single-seaters and was posted to *Jagdstaffel 5* in June 1917 and then to the elite *Jagdstaffel Boelcke*. In May 1918 he was injured in a crash, but he returned to the front again in September. He received the *Pour le Mérite* shortly before the armistice in November 1918 and was credited with 43 victories. After the war he also established his own aviation firm, Bäumer Aero, in Hamburg. On July 13, 1927, he took off in Bäumer Sausewind D-1158 to fly to Copenhagen.

Bäumer had been engaged by Rohrbach to demonstrate the Rofix in Turkey and came to Copenhagen in order to familiarise himself with the aircraft before the Turkish acceptance trials at Kastrup. It was made ready for handing over to a couple of Turkish officers in Copenhagen, and was painted in a new colour scheme with prominent Turkish national insignia.

On July 15 Bäumer was about to make his sixth flight in the Rofix and mentioned that he intended to spin the aircraft from high altitude. Earlier the same day he had performed

German pilot Paul Bäumer beside his Sausewind, D-1158. Designed by Walter Gunter, the aircraft sported an elegant elliptical wing and a smooth plywood monocoque fuselage. Gunter and his brother Siegfried joined Heinkel after Bäumer's death, the Sausewind becoming the blueprint for the innovative He 70 and, ultimately, the He 111 bomber. VIA AUTHOR

VIA AUTHOR

aerobatics in his own Sausewind and also flown the Rofix. He took off at 1917hr, climbed to 3,000–4,000m (10,000–13,000ft), performed some rolls and then entered a spin. The latter was arrested after three turns, and the aircraft flew horizontally for a while, but then it started to spin again. After eight or nine turns the engine revved up momentarily, but the spin continued. After perhaps another eight turns the engine was heard to rev up again; this at first seemed to pull the aircraft out of the spin, but it continued. At about 400–500m (1,300–1,600ft) over the sea, the engine was revved up again and at 1933hr the Rofix crashed into the water.

END OF THE ROAD FOR THE ROFIX

Four minutes later a motorboat was on the spot, which was marked by an oil slick, two floating wheels and some other parts from the undercarriage. There was no sign of the pilot. In the evening the wreck was observed lying on the seabed by the crew of an aircraft from the Danish naval aviation service. A diver established the following day that the engine had separated from the fuselage, which had snapped behind the cockpit. The pilot was still sitting in the cockpit with his hand on the stick, but he had unstrapped. No mechanical faults were found when the aircraft was salvaged from the water and Bäumer was thought to have been unconscious when the aircraft hit the sea. Rohrbach designer Kurt Tank remarked in a report that a large fighter of this type with a powerful engine should be spun at half-throttle, not throttled back, otherwise the tail surfaces would have no effect.

Rumours circulated about the cause of the crash, most probably untrue. German aviation magazine *Flugsport*, for example, reported five days after the accident that it had been caused by defective controls. Armand van Ishoven wrote in his Udet biography that Bäumer had taken off at 0800hr after a night of drinking, which is definitely false. It has been alleged that Adolf Rohrbach burned all construction plans on the day of the second Rofix crash. In any case, development of the fighter was discontinued. Turkish officers Enver and Muzaffer, who had been in Copenhagen and had expected to take over the Rofix, returned home. In the event the Dewoitine D.21 won the fighter competition, but only ten were acquired.

ABOVE ***The announcement from Rohrbach on the crash of c/n 23 stated that "the cause of the crash can only be guessed, but it is probable that the 35 or more revolutions of the machine made Bäumer nervous", to which British magazine* The Aeroplane *responded: "One can hardly imagine a pilot of Herr Bäumer's experience and proved bravery becoming 'nervous'".***

LENNART Andersson is co-author, with Rob J.M. Mulder, of the newly published 8½in x 11½in hardback book, *Rohrbach: German All-Metal Aircraft Pioneer*, published by European Airlines (ISBN 978-8-293450-11-5, RRP £26 + p&p). For more information, visit **www.europeanairlines.no**

$$V_{MAX} = \sqrt{(35{\cdot}18\sqrt{(518{\cdot}7 - (3{\cdot}57A/1000)) \times (1-(0{\cdot}568(T/\sqrt{H}))2)} - (0{\cdot}0357P \times R \times D)^2}$$

THE OTHER SOUND BARRIER

Supersonic shockwaves — the true limiting factor for propellers?

In the wake of his investigation into the Westland Whirlwind fighter's notorious propulsion problems in *TAH20*, **MATT BEARMAN** set about delving further into the complex, often counterintuitive, world of propellers and the forces at play on them. The results were surprising — and could potentially rewrite the history behind some enduring myths and mysteries

IN THE EVENING of September 2, 1940, Avro's chief test pilot, Harry "Sam" Brown, looked on disapprovingly as Mr Gillmore once again took a spanner to the propeller hub of the company's latest bomber prototype, Avro Manchester L7246, at Woodford. Brown then turned his attention back to writing his daily log: "The chap from de Havilland doesn't seem to know his job".[1] The following day he recorded making a decision; he would not fly the aircraft again until its propeller problems had been resolved. Brown took L7246 up again on September 27 — only to be disappointed once more: "Eighth attempt; 43min flight in fairly good weather. Propellers badly adjusted and hydraulic pumps failed".

The Manchester just hadn't been right from the start. Of course it was the Rolls-Royce Vulture engines that were the problem — or so it seemed — just as the same company's Peregrines had been for the Westland Whirlwind (see the author's *The Whirlwind Becalmed* in *TAH20*). The thing just would not go as fast or as high as the design calculations had said it should. That could surely only be the engines, and the apparent incompetence of the propeller people had compounded it. Sometimes the blades just wouldn't come out of fine pitch no matter how much power was put on, or however much the "coarse" switch was held down on the Exactor pitch control. The latter eventually lost pressure altogether, which didn't help — much as with the Whirlwind, in fact.

If a pilot did manage to come out of fine pitch, the Manchester would get up to altitude and just get noisier and noisier until the pitch mechanism did something alarming or the quill-shaft driving the hydraulic pump broke. There was also the vibration of the engine, aeration of the oil and overheating to contend with. Brown's log continued the litany of setbacks:

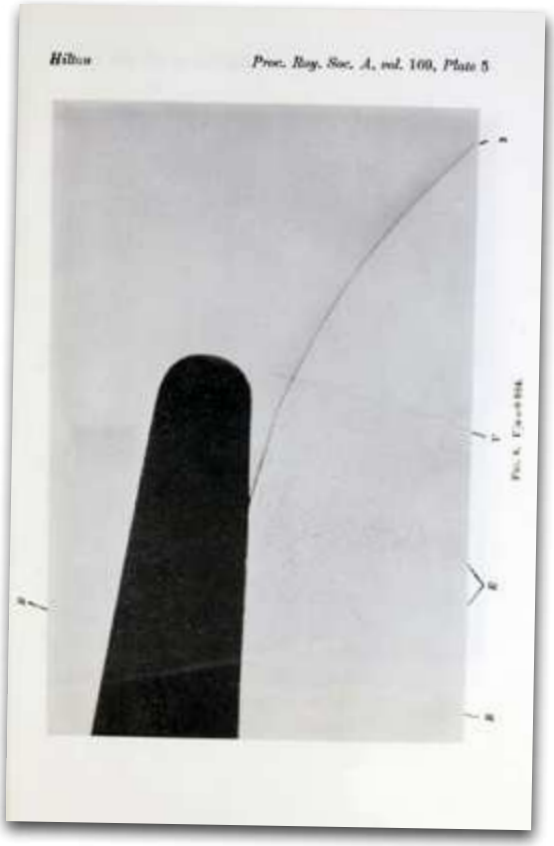
"April 25, 1941: L7246, 30min. Had trouble with the propeller-pitch mechanism. Won't fly it again until de Havilland sort[s] the problem.

"April 26: L7246, airborne 25min. Propellers still very unsatisfactory.

"April 28: L7246, take-off 1130hr. Pitch mechanism better but still wanting adjustment."

Later that afternoon he wrote, "with Mr James of Rolls-Royce and Mr Gillmore of de Havilland. Take-off 1500hr; 5min after take-off the starboard Vulture packed up. Staggered back to Woodford and forced-landed with great difficulty".

One Avro engineer told Robert Kirby, author of the excellent *Avro Manchester — The Legend Behind the Lancaster* (Fonthill Media, 2015): "We used to listen to Manchesters taking off from Woodford. If the whine of the propellers continued after 1,000ft [300m] and hadn't changed into coarse [pitch], sure enough there'd be a 'bang' as the unit went and then the engine failed".



VIA AUTHOR

ABOVE ***The "smoking gun"? In 1938 Professor W.F. Hilton took this photograph of a supersonic shockwave produced by a propeller blade moving at Mach 0·984. The wave (the curved line coming off the prop about two-thirds of the way up its length) leaves the surface at the point where the flow becomes supersonic, and is essentially a "mini sonic boom".***

Rolls-Royce issued "Modification 44" in June 1941. As well as altering nut-tightening limits and relieving the strain on con-rods it also reduced permissible r.p.m. from 3,200 to 2,850. Now the engines began lasting as long as they were supposed to — 120hr between overhauls, rising to 180 with experience. The curious thing about this change was that performance also improved. The Aeroplane & Armament Experimental Establishment (A&AEE) at Boscombe Down had already noted this during acceptance trials. Counter-intuitively, reducing r.p.m gave shorter take-off runs and higher maximum true airspeeds (TAS).[2]

OPPOSITE PAGE ***The Avro Manchester prototype L7246 with its original twin-finned tail, before a third central fin was added. The Manchester made its first flight in the hands of "Sam" Brown at Ringway on July 25, 1939, but suffered from recurrent powerplant problems and in total only 202 were ultimately built.*** PHILIP JARRETT COLLECTION

"On one occasion the Albemarle's blades on one side had gone quiet and into coarse pitch for no reason, and it took some airmanship to get the aircraft back on terra firma . . ."

TAH ARCHIVE

ABOVE ***Built to Air Ministry Specification B.18/38 for a "Reconnaissance Bomber for Rapid Production", the Armstrong Whitworth Albemarle was powered by a pair of Bristol Hercules radials of considerably less power than the Manchester's Vultures — yet it was even noisier for its crew. Was the problem similarly propeller-based?***

Aside from this apparent quirk, one other major issue was noted; the engine noise at the pilot's seat was found to be very high. A rapid and deep beat seemed to drum on the inner ear in an extremely uncomfortable way. After a couple of hours this became unbearable for the pilot, seated only 3ft (0·9m) from the propeller tips, while at the nearby navigator's and wireless-operator's stations it wasn't nearly so bad.

THE NOISE ISSUE

In a remarkable series of tests conducted in 1941 by the Royal Aircraft Establishment (RAE) at Farnborough, the noise levels within bomber aircraft were compared and soundproofing explored. Crew comfort was becoming a genuine factor of concern as sorties were rapidly increasing in duration. It was stated in Reports & Memoranda (R&M) No 2491, *Measurement of Cabin Noise in Bomber Aircraft*, that the Manchester was "noisy" (while the Lancaster was only "average"), and that Armstrong Whitworth Aircraft's (AWA) Albemarle was "excessively noisy". The frequencies were around three or six times the rotation speed of the props, as if each blade was shedding a pressure wave and flinging it past the cockpit.

Indeed, this is exactly what was happening. This wave had even been photographed in 1938 by perhaps the greatest of the UK's "forgotten" scientists, William Frank Hilton. In a presentation to the Royal Society, Hilton identified this wave for what it was: a shockwave that would absorb large amounts of a propeller's energy; but this apparently failed to register with the airscrew fraternity. After the war Hilton led Britain's space programme until his forced redundancy from Hawker Siddeley in 1961. He co-designed the "Waverider" manned spaceplane based on his understanding of shockwave propagation and established the techniques and principles of re-entry for manned spaceflight, largely uncredited.

Back to 1941. The RAE had already commented that the Albemarle's speed curiously increased with a reduction in r.p.m.[3] Another problem concerning the Albemarle was a recurring failure of the constant-speed mechanism, a frequent bugbear of Charles Turner Hughes, AWA's chief test pilot. On one occasion the Albemarle's blades on one side had gone quiet and into coarse pitch for no reason, and it took some airmanship to get the aircraft back on *terra firma*. A technician sent by de Havilland subsequently found leaks in the Exactor pitch-control pipes.

Significantly, the propellers fitted to the Manchester and the Albemarle were unusually large. Those of the Manchester required a new blade design from de Havilland; there was nothing "off the peg" available in the Hamilton Standard drawings shipped from the USA that would provide the 16ft (4·8m)-diameter needed to absorb the Vulture's power. In theory this was more than 1,700 h.p.; the Vulture was essentially two 870 h.p. Peregrines bolted together. The requirement was for a bomber that could cruise at 300 m.p.h. (483km/h). This was the presumed standard in 1938 when Specification P.13/36 for a medium bomber was drawn up by the Air Ministry, and there would have been much head-scratching all round when nothing large seemed to want to go that fast, least of all the big-propped Manchester, which tried to shake itself apart by the engine mounts whenever it reached 250 m.p.h. (402km/h).

It seemed as though big engines just weren't delivering as promised — the Manchester never

got past 265 m.p.h. (427km/h) — despite all the power going through those huge airscrews. It couldn't be the props themselves, of course; the Short "G" Class flying-boats had 14ft 6in (4·42m)-diameter units turning at similar tip-speeds quite happily all around the world.

A long way from Woodford, in a cold hangar at the Wright Field test centre in Dayton, Ohio, a Curtiss-Wright technician doubtless had a similar expression to de Havilland's Mr Gillmore as he took a screwdriver to the torque meter his company had installed between the prop and driveshaft of Curtiss P-36 serial 38-180. The thing was screwy again; at high revs and especially at altitude, it was telling him and the increasingly annoyed Army air staff that the engine was, if anything, gaining power with altitude. The torque meter was tweaked and insulated against ice accretion in the thin winter upper air. Still, on flight after flight, the same result. The thing just seemed to be generating weird amounts of torque; sometimes it was going up with r.p.m. while the aircraft went slower, sometimes it was just way off the bench-test power curves. The authors of the report stated that things were "clearly in error", the implication being once again that somebody didn't know their job.

While Curtiss propellers seemed to cause engines to deviate from power curves in all directions, aircraft fitted with de Havilland or Hamilton constant-speed-propellers seemed limited; there was a barrier beyond which no amount of extra power would take them, and it was at its starkest at maximum speed at full-throttle height (FTH — see adjacent glossary). Every aircraft had its own barrier, and it seemed to be defined by propellers.

PERFORMANCE LIMITATION

In early 1941 the Bristol Hercules engines fitted to the same company's Beaufighter were cleared to take a few more inches of boost. This meant they could turn over at 2,900 r.p.m., buying a few more horsepower which the RAF happily assumed would make the aircraft something of a hot-rod at low altitude. This did not happen, however; the faster-turning engines actually made the aircraft slower at FTH, much like the Albemarle. Farnborough's report concluded: "It would appear that the increase of power due to increasing engine r.p.m. is small and that the decrease in propeller efficiency at the higher r.p.m. produces a net decrease in thrust horsepower in this case".[4] Both conditions mentioned in that paragraph — 334 m.p.h. (538km/h) at 2,800 r.p.m./1,565 h.p. and 333·5 m.p.h. (536km/h) at 2,900 r.p.m./1,635 h.p. — are up against what looks like a limiting factor.

The Lancaster was rapidly erasing memories of

GLOSSARY Compiled by Matt Bearman

Full-throttle height (FTH) This is the height at which the throttle may be opened fully without risk of detonation from over-boosting by the supercharger. Below full-throttle height, boost must be kept below a rated maximum and this is done by regulating the throttle. Thus a supercharged aircraft engine will not reach maximum power output until it reaches full-throttle height. Above this height the throttle may be held open but power will progressively decrease with boost, this being a function of outside air pressure. The full-throttle height of an engine is sometimes referred to as the **rated altitude** — the height at which it will provide rated (maximum achievable) horsepower at rated (maximum allowable) boost and rated (peak power output) r.p.m. Crucially, this is not exactly the same as the altitude of maximum performance for propeller aircraft.

V_{max} I have used **maximum achievable speed** in level flight as an indicator of performance, as this occurs at a point where all the variables are known or approximated from performance tests — full throttle, optimum r.p.m., rated altitude. Available horsepower will in fact vary (as the recorded height of V_{max} is not always "rated altitude") but only by fractions of an m.p.h. — propeller characteristics are mathematically more important than slight variations in power in defining V_{max} in this critical region.

Reynolds number For all of the confusing definitions that surround it, the Reynolds number is just the chord of the aerofoil times the speed of the aircraft divided by the kinematic viscosity of the air — how fast the air can accelerate out of the way when hit by a fast-moving aerofoil, normally reckoned at being something around 0·000013m/sec². This means that Reynolds numbers for full-size aircraft can be high, 20,000,000 or more, although 20,000,000 *what* is unanswerable, as the units divide out to make the Reynolds number dimensionless. Essentially, the faster you go, the higher the Reynolds number. An aerofoil, even an example taken from a full-sized aircraft when tested at low speed (as in most 1930s windtunnels), might show laminar flow where at a higher Reynolds number it would be turbulent. This is because the size of dust particle, moisture-droplet or paint-fleck that will trigger a transition reduces directly with increase in Reynolds number.

P-factor When an aeroplane is not pointing directly along the imaginary line of travel, the propeller disc will not be 100 per cent perpendicular to it. This means that the blades on the downgoing side are also moving forward relative to the aircraft, and those on the up backward. The downgoing blades are moving through the air faster overall than the upgoing ones. The downgoing blades will generate more lift, but will also hit Mach problems earlier. Once in the transonic zone, the position and behaviour of shock will be different between the two halves of the disc.This produces an imbalance of forces which switches back and forth on each blade with every revolution. Centre of pressure (CP) movement can set up a twisting flutter, and moment changes can even vibrate the engine crankshaft.

PHILIP JARRETT COLLECTION

ABOVE ***In his article in*** **TAH20, The Whirlwind Becalmed,** ***the author explained how the second Whirlwind prototype, L6845, was fitted with experimental Rotol propellers for trials at the A&AEE, giving notably better performance than the thicker de Havilland propellers fitted to production machines such as P7048, seen here.***

the Manchester with its comparatively sparkling performance with four Rolls-Royce Merlins fitted with a more rational prop-diameter of 12ft 6in (3·81m). The Lancaster was also right up against the limiting constant, the only significant change in performance occurring when the drag on the prop blades owing to compressibility (i.e. "Mach drag") was reduced with the introduction of the Nash Kelvinator paddle-blade propeller, imported from Detroit. The effective thickness, factoring in the new laminar-flow section — laminar-flow theory working for low Reynolds-number prop blades (see glossary) — was reduced, and the speed at FTH went up. The limit, which can be derived mathematically from that effective thickness, remained.[5]

Constant-speed systems are there to maintain peak efficiency. Just as happened with the Whirlwind, no constant-speed mechanism can tell what is causing the engine to slow down; it just fines the propeller blades anyway to speed it up again. When a blade hits a certain speed relative to local Mach (the speed of sound in the specific region of the object in question), shockwaves make the torque shoot up as lift and parasite drag increase exponentially for every fraction faster than a speed specific to that blade. The engine starts to slow, and the blades fine in response; they generate less thrust and the aircraft goes slower as a result.

Three years ago I was making my brain hurt with visualisations of the Whirlwind's fat de Havilland propellers and had begun to create sprawling spreadsheets and muttering to myself, much to my family's concern. The "eureka moment" came while working in the shed at the bottom of the garden. As propeller Mach — and drag — rises and the propeller fines, an equilibrium is reached that is an upper limit to performance, regardless of any other design factor. Crunching numbers produces a rule of thumb which can predict the point at which an aeroplane with a de Havilland constant-speed prop will not go any faster in level flight, no matter how much more r.p.m. is poured on, without improving the blades.

It is surprisingly accurate. Using just blade thickness and engine power, disregarding weight and drag completely, it predicts the Whirlwind at full throttle as capable of 349·5 m.p.h. (563km/h); Albemarle, 260 m.p.h. (418km/h); Manchester, 265 m.p.h. (427km/h); Blackburn Roc, 223 m.p.h. (359km/h) and the Beaufighter VI 334 m.p.h. (538km/h) — and no more. It is not possible to tell the speed of a design from the propeller, but in this case, one can tell its speed limit. It could have been easily fixed, and other designs of variable-pitch propellers around the world regularly broke through this "other sound barrier", by sheer brute force.

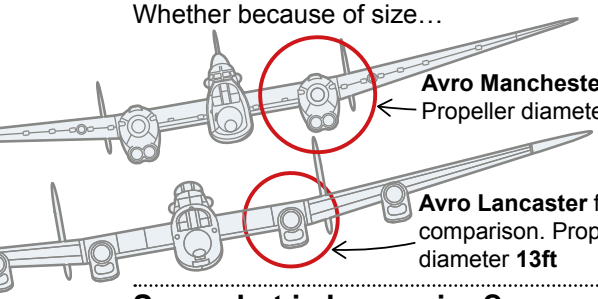
MEANWHILE, IN AMERICA . . .

In 1941 a report relating to tests undertaken by the US Army at Wright Field stated that bench test data for the Lockheed P-38's Allison V-1710-27 engine appeared "doubtful", as flight data showed that 300 extra h.p. was apparently needed to get from 319·5 m.p.h. (514km/h) to 322 m.p.h. (518km/h) by increasing r.p.m. The report also went on to state that "practically all flight tests on airplanes equipped with torque meters show that the power-chart method for determination of b.h.p. [brake horsepower] is not reliable".

The P-38 had two Curtiss Electric controllable propellers, and the way to increase thrust was to

Increased blade tip speed causes problems

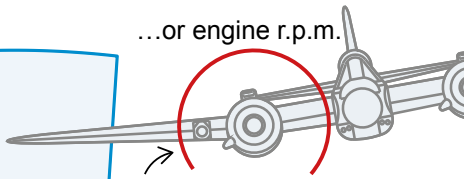
Whether because of size…



Avro Manchester
Propeller diameter **16ft**

Avro Lancaster for comparison. Propeller diameter **13ft**

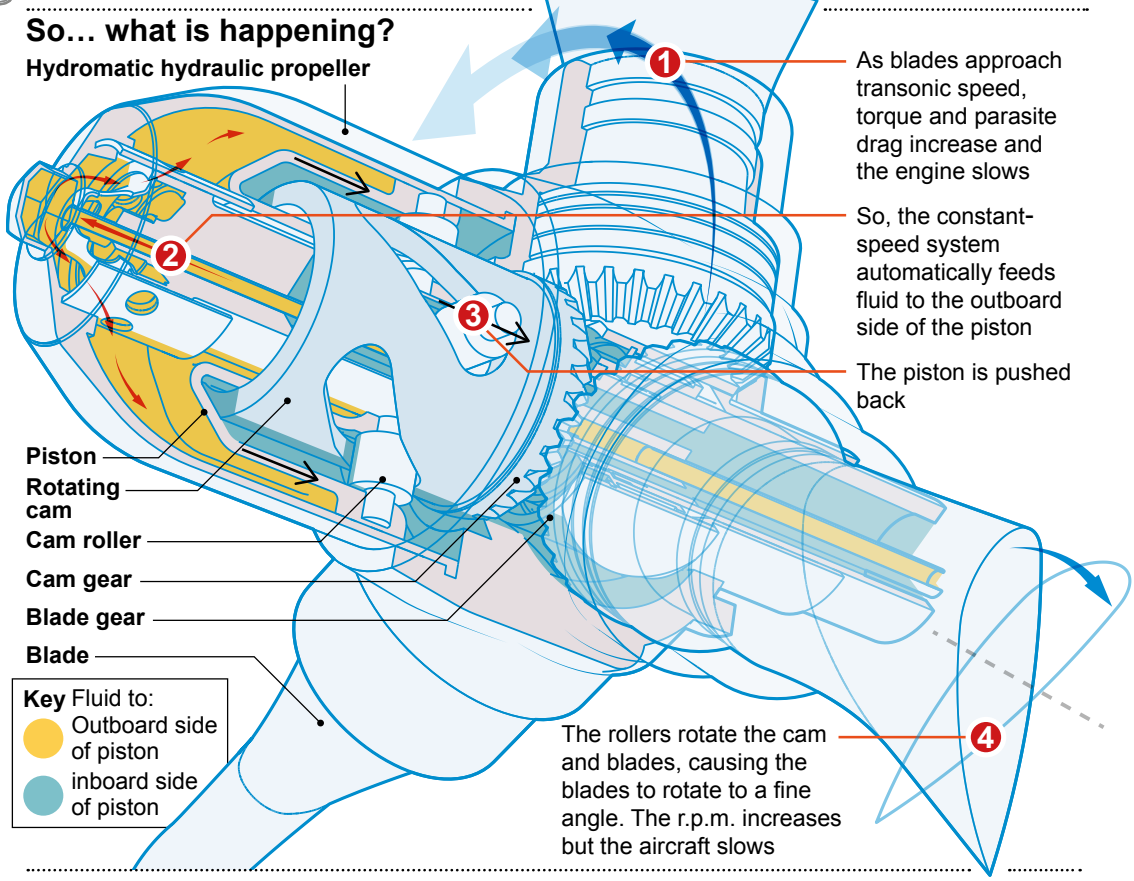
…or engine r.p.m.



The cleared r.p.m. of the **Beaufighter's** Hercules was increased to **2,900** in 1941

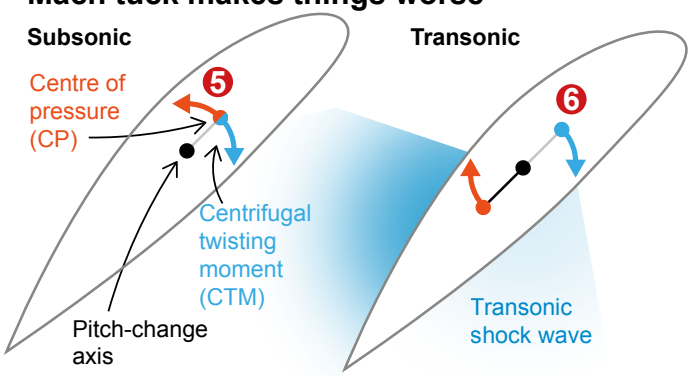
So… what is happening?

Hydromatic hydraulic propeller



1. As blades approach transonic speed, torque and parasite drag increase and the engine slows
2. So, the constant-speed system automatically feeds fluid to the outboard side of the piston
3. The piston is pushed back
4. The rollers rotate the cam and blades, causing the blades to rotate to a fine angle. The r.p.m. increases but the aircraft slows

Mach tuck makes things worse



Graphic: Ian Bott *www.ianbottillustration.co.uk*

5. CP ahead of pitch-change axis pushes the blade to a coarse angle, balancing CTM's tendency to fine the blade angle

6. Transonic shock waves move CP back past pitch-change axis, now both CP moment and CTM push the blade to a fine angle. The force can overcome the constant speed system's hydraulic pressure, hindering and damaging it

NASA

ABOVE ***Bell P-39 serial 40-034 while up from Langley in 1943. The aim was to test the effects of compressibility on propeller blades, and required the aircraft to hold various level-speeds down to 200 m.p.h. (322km/h) at a constant blade angle-of-attack. The results were the first to measure a transonic drop in torque beyond the "barrier".***

keep the pitch where it was — known as "locking off" — and open the throttle. This was not so easy with a Hamilton, de Havilland or non-electric Rotol constant-speed prop. It meant that Curtiss-equipped aircraft could go a little faster, even with a standard thickness ratio of nine per cent. Much of the Curtiss blade was stalled by the time the sudden drag rise, akin to a sound barrier, was passed; it was hardly efficient in the way the de Havilland/Hamilton system was, but if there was horsepower to spare the aircraft would go faster.

Feeding the numbers in shows 320 m.p.h. (515km/h) to be on the limiting line. This is where a de Havilland prop would stop the acceleration to maintain efficiency, but the controlled Curtiss prop just keeps thrashing away until it's "past the hump". At 322 m.p.h. (518km/h) and 3,000 r.p.m. the fat blade is largely beyond the point of drag rise, lift is falling off and it is in the happy zone where moment coefficient — essentially propeller torque — just drops away.

North American's P-51A, fitted with a Curtiss Electric propeller, had a similar ability to transcend the barrier, and in so doing confused the boffins at Wright Field as much as the P-38 had. A wobble in the data, they wrote, might be because "the carburettor ram-pressure decreases slightly at engine speeds above 2,600 r.p.m., or the engine power curves are in error".[6]

Later NACA tests conducted with a Bell P-39 "locked off" in coarse pitch showed torque dropping by up to 12 per cent, as efficiency fell by 18 per cent beyond the "hump".[7]

Confusion persisted on both sides of the Atlantic owing to the practice of taking the height of maximum speeds as being FTH. In their comparative reports on the Lancaster with needle- and paddle-blades, the A&AEE even went so far as to say: "It has been found that all full-throttle heights have increased slightly, but no particular significance is attached to this". Of course, where blades were correcting pitch for Mach, variations in the altitude of peak V_{max} (see glossary) were down to propellers; the difference between "brochure" FTH of the Whirlwind's Peregrines and the height of peak performance — mirroring the difference in ceiling — was blamed on Rolls-Royce and/or Exactor Controls Ltd, rather than investigated.

THE PENNY DROPS

Tests on different propellers on a Supermarine Spitfire Mk I moved the apparent FTH of the Merlin up and down, while the thicker-bladed (nine per cent, as opposed to 7·6 per cent) Rotol constant-speed prop tested on Mk I N3171 by the A&AEE made it go 4 m.p.h. (6km/h) faster at 2,800 r.p.m. than at full power, 3,000 r.p.m. and FTH. The A&AEE report states in section 4.2:

"Controlling r.p.m. — the results show that the

NASA

LEFT ***American aerodynamicist John Stack joined the staff of the Langley Memorial Aeronautical Laboratory as a junior aeronautical engineer in July 1928, and undertook pioneering work on high-speed propellers during the 1930s. Stack later went on to become one of the leading lights of the USA's Bell X-1 project, the world's first aircraft to exceed the speed of sound.***

maximum level speed is reached with the airscrew controlling at 2,800 (engine) r.p.m. On increasing the r.p.m. to 3,000 the speed was reduced, on the average by 4 m.p.h. For the particular engine fitted there is a reduction of 17 b.h.p. at constant boost (+6¼lb) when the r.p.m. are increased from 2,800 to 3,000. The loss of speed is therefore probably due to the loss of power accompanied by a slight decrease in airscrew efficiency. The matter is being further investigated by Rolls-Royce and Rotol. It will be noted that reducing the r.p.m. from 3,000 to 2,800 lowers the FTH by 2,000ft [600m]."

There is no indication that the 17 b.h.p. drop of the "particular engine" mentioned in the report was ever measured directly, and it was almost certainly an illusion caused by the difference between "zero altitude" bench tests and tests at height with high tip-speeds.

The penny had evidently dropped, at least for the A&AEE, by January 1942, when Messrs Hislop and Wier published Reports & Memoranda No 2212, *The Variation of Power with Height of the Merlin XX Engine as determined by Flight Tests on a Hurricane II*. They dispensed with torque meters altogether, instead using a Rotol electric constant-speed propeller (which could be "locked off" as per the Curtiss model) and measuring speeds. Performance was combined with an airscrew Mach drag factor taken from RAE calculations to establish the actual power output of a Merlin XX at altitude.

This method (essentially applying the same logic as mine) was successful, and was applied to a Spitfire Mk II and Mk V. The adoption of propeller compressibility effects as part of "performance reduction" was, interestingly, pioneered by the same A&AEE staff that ran the bomber noise tests, Messrs D. Cameron and W.J.P. Annand. At last, power curves were agreeing with bench tests and "brochure" — but there was no fanfare and no attempt to revise what had gone before, including addressing the blame laid at the door of engine manufacturers.

"MACH TUCK"

None of this, however, explains why the Manchester had such trouble even getting airborne. To do so takes another supersonic phenomenon covered by this author in *Lockheed Consternation* in *TAH*23. As well as raising drag, a shockwave on an aerofoil (which is what a propeller blade is) will move the centre of pressure — and lift — rearwards. Normally an adjustable propeller lifts ahead of the axis of rotation of the blade. This goes towards balancing a slight tendency towards fine through an effect known as centrifugal twisting moment (CTM). The forces acting on the pitch-changing blade-turning mechanism itself are essentially in balance.

An effect known as "Mach tuck" affected the P-38 extensively. In a dive the massive shockwave set up by the ill-thought-out wing/body junction moved progressively backwards, taking the lift with it aft of the centre of gravity and tipping the aircraft into an irrecoverable dive.

The same forces act on fat non-laminar-flow propeller blades. American aerodynamicist John Stack, in the same paper I used to validate my Whirlwind findings, also noted the dramatic effect on pitching moment of increased Mach. This was not new even then; as early as 1923, in work generally ahead of NACA, British researchers R. McKenzie Wood and G.P. Douglas noted the effect in their paper *An Experimental Investigation of an Airscrew Over a Range of Speeds in Excess of the Velocity of Sound in Air*, but Stack measured it with springs and balances.[8]

The licence-built de Havilland Hydromatic units used a pump-driven hydraulic circuit to coarsen the blades. As mentioned, Avro test pilot Sam Brown had reported "badly adjusted propellers and failed hydraulics" numerous times while flying the Manchester; and, when this was apparently solved, vibrations back through the propeller shaft begun shaking engines apart. Because they were the largest Hydromatic blades

BAE SYSTEMS

ABOVE ***D.H. Propellers was forced to create the DP456250A prop-blade "in-house", as there was nothing readily available that was big enough for the Manchester's Vultures. Despite the scaled-up blades pushing into uncharted regions of power transmission, the Vulture has always taken the brunt of the blame for the type's poor performance.***

used up to that point, the turning forces would have been the largest ever encountered by a pitch-change mechanism. Unlike the Curtiss Electric design with a worm-gear that effectively "locked", blade pitch was only held by around 350lb/in² hydraulic pressure. Rough calculations show that a 2in (5cm) rearward movement of the aerodynamic centre at 0·7 radius, when coupled with CTM, would be enough to push back on the hydraulic system. This wasn't entirely unprecedented. It was frequently found that the pump on early Hydromatic propellers could not provide sufficient force to feather a windmilling DC-3 propeller, especially at altitude. The theory awaits an engineer with a computer model.

After take-off with Hydromatic constant-speed propellers, the pilot was instructed to adjust the r.p.m. downwards, via the Exactor control; this translated into moving the blades from the fine-pitch stop to some self-defining setting that made the engine a little slower. By now the blades would be setting up shockwaves and the Mach-tuck twist holding the propellers in fine pitch, resisting all movement. The bangs heard by the Woodford engineers may have been the back pressure on the hydraulics as they struggled against an increasingly immovable object causing a rupture somewhere in the system. Usually it was either the engine-driven pump that failed first or one of the solenoids.

The destruction of the engine of Sqn Ldr Anthony Martindale's Spitfire XI in the famous high-Mach dive over Farnborough in April 1944 has often been put down to sheer speed. But Farnborough's own account tells a more nuanced story; R&M No 2222 states:

"The dive was very steep, and the loss of oil pressure to the constant-speed unit resulted in severe overspeeding of the propeller. The reduction gear and propeller were torn away, thus preventing any further tests from being made on this aircraft."

The propeller overspeeded, despite being fully featherable, because the Rotol hydraulic pitch-change mechanism itself failed — and the only strain on that mechanism was torsional.

FLYING-BOAT DISCREPANCIES

But what of the Empire flying-boats with their big propellers? The "G" Class flying-boats were putting 1,380 h.p. through 14ft 6in-diameter propellers as early as 1939. The difference here is that the force applied by the pitch-change mechanism's hydraulics was towards fine pitch, in sympathy with any Mach tuck, with counterweights otherwise holding them in coarse pitch. However, another flying-boat with propellers of the same diameter was the Saunders-Roe Lerwick. Sometimes called the "flying pig", it was hated by crews, largely because the normally reliable Bristol Hercules engines would behave unpredictably on take-off. The Lerwick had the same propellers, engines and Exactor controls as the trustworthy "G" Class 'boats and the only difference was the Hydromatic propeller pitch-change mechanism.

Despite the clues revealed by Wood, Douglas and Stack, Mach-tuck was not studied any further, as far as it is possible to tell, in relation to propellers, although the very same phenomenon was recognised later in relation to rotorcraft. In a 1977 US Army helicopter design manual, Leo Dadone wrote: "Only relatively recently the growth of pitching moments with Mach number has become a significant parameter. The phenomenon has been referred to as 'pitching-moment-break' or, borrowing the term from fixed-wing terminology, 'Mach tuck'". [9]

EN ARCHIVE

"The Luftwaffe's Heinkel He 177 Greif had 16ft-diameter propellers designed to take the power of a Daimler-Benz DB 606 — which overheated, shook and leaked oil just as the Manchester's Vulture did . . ."

ABOVE ***Perhaps unsurprisingly, German powerplant specialists experienced many of the same issues as their British counterparts when putting high power outputs through enormous propellers. The 16ft (4·87m)-diameter propellers of the Heinkel He 177 potentially caused the loss of a prototype when the pitch-change unit failed.***

Once past the critical take-off phase, and with the blades coarsened for thrust, the shockwaves running up and down the blades in high-frequency flutter modes may go on to set up enormous vibrations and lateral strains on the drivetrain. It is little surprise that things frequently just broke.

As early as 1938 it had been established, in a classic NACA paper by Biermann and Hartman, that 75 per cent of the way along its length, a standard metal blade vibrated with a twist of up to 2° when the tip was at 539 m.p.h. (867km/h) — just Mach 0·71 at ground level; a Manchester's prop tips could reach 0·87 at FTH. In the words of the paper's authors: "The amplitude of the tip section vibration was probably much greater".[10]

The Hawker Typhoon vibrated permanently at a very unpleasant high frequency (among other noises and shakes) in early models. Extra springs in the seat were needed, while reconnaissance photos taken in the type were always blurred. A thinner four-bladed propeller removed this "buzz" from the repertoire.

In 1943 de Havilland put a 12ft 6in (3·81m) 55206 propeller, attached to a Merlin II engine, into an RAE test rig to study resonances. This was the engine/propeller combination of the Fairey Battle and it produced a clear increase in vibration through the crankshaft at a Mach and pitch angle (0·52 and 22·5° respectively) at which Stack's work suggests the tips would be hitting compressibility.[11] The Battle was in fact limited in top speed, propeller calculations as per previous examples indicating the recorded FTH speed of 260 m.p.h. (418km/h) was only attainable at 2,850 r.p.m., and not possible at full throttle at 3,000 r.p.m. The vibration was at exactly six times the three-bladed propeller's speed (as was the "drumming" reported on the Albemarle) and, because of reduction gearing, two-and-a-half times the crankshaft speed (i.e. not resonant with it); the fact that it added up to an effect that only came on at high Mach was not discussed, and neither was the observation made by Hilton that the laboratory floor reflected shockwaves.

The effect of compressibility on a propeller is to make the blades much less stable and more prone to flutter, especially when exacerbated by P-factor (see glossary).[12] The torsional stresses and moments resisting and vibrating the engine via the drive could easily result in damage. It may be impossible now to know how many overheating and oil-hungry engines were really just suffering from their big propellers at high Mach, but it is interesting to note that the Luftwaffe's Heinkel He 177 Greif had 16ft (4·87m)-diameter propellers designed to take the power of a Daimler-Benz DB 606. The latter overheated, shook and leaked oil just as the Manchester's Vultures did. It is also interesting that the He 177 V4 prototype crashed into the Baltic after the propeller pitch-change mechanism failed.

OMISSIONS FROM THE RECORD

By 1944 the A&AEE had established that the Merlin-powered P-51 and Vought F4U Corsair, as with many other Hamilton/de Havilland-equipped aircraft, went faster when r.p.m. was dropped below "optimum", yet nobody wanted to mention the elephant in the room — the limitation placed on performance by the pitch-changing principle of the Hydromatic propeller.[13] Published work seemed to skirt around this limitation, as well as blade vibration and Mach tuck, without addressing them directly: "temperature effects"; "gearing effects" and even "particular conditions" appear almost euphemistically. Meanwhile, NACA report

FOR THOSE WHO LIKE THEIR MATHEMATICS "CHALLENGING" . . .

THE SCIENCE BIT **Matt Bearman**

I HAVE TRIED to avoid too much complicated mathematics in this article; but if anybody is interested to try it, the relevant constant-speed limiting equation is as follows:

V_{max} = √ (35.18 √ (518.7 – (3.57A/1000)) x (1-(0.568(T/√H))2)) – (0.0357PxRxD)2

Where:
V_{max} is the maximum speed that aircraft will attain with a specific blade, in m.p.h.;
T is the ratio of blade-thickness to blade-chord at 75 per cent along the length of the blade (assuming a non-laminar aerofoil);
A is the altitude at which maximum speed is reached, in ft;
D is propeller diameter in ft;
R is reduction-gear ratio;
P is crankshaft r.p.m. at rated maximum power output;
H is that output in horsepower

As a worked-out example, let's look at the performance of **Avro Manchester L7277** during acceptance trials at the A&AEE in August 1940:
T = 9·6 (assuming similarity with DH 54409)
A = 17,000ft
D = 16ft
R = 0·35:1
P = 3,000 r.p.m.
H = 1,710 h.p.

Using these figures, **V_{max} = 265 m.p.h**. This was indeed the precise measured maximum true airspeed (TAS) as per the A&AEE's report.

Let's take another example — **de Havilland Mosquito** with Rolls-Royce Merlin 21 engine and early propeller blades:

T = 7·2
A = 19,200ft
D = 12ft
R = 0·42:1
P = 3,000 r.p.m.
H = 1,160 h.p.

V_{max} = 367 m.p.h.

Propeller blades could make a significant difference — Mosquito, same engine, 445-series blades:

T = 6·9
A = 19,450ft
D = 12ft
R = 0·42:1
P = 3,000 r.p.m.
H = 1,160 h.p.

V_{max} = 380 m.p.h.

Using this equation, the propeller-limited speed of hypothetical **Albemarle** at full-throttle height with 445-series blades = 275 m.p.h.
Westland Whirlwind = 411 m.p.h.

L4B28 (on pusher propellers) stated in passing that compressibility would serve only to increase the forces on the blades and thus the amplitude of any oscillations, but nobody seemed keen to address this either.

A series of NACA reports looked at efficiency in terms of lift and drag approaching Mach 1, but dropped Stack's third effect — moment and torque changes. Although engineers on both sides of the Atlantic were establishing where the problem lay as far as was necessary to take mitigating action, both public and industrial research and development seemed to sidestep the issue. Charles Kearns of Hamilton Standard was solely focused on resonances and was keen to suggest that all destructive forces were the fault of the engine rather than the propeller.[14]

George Brady, Chief Engineer of Curtiss-Wright's propeller division, confidently posited a simple ratio of efficiency to size in the face of all of Stack's work, right up to a spectacular *volte face* in 1948 with his paper *Propellers for High Powers and Transonic Speeds*, presented as new thinking and unsurprisingly not mentioning the revelatory performance of the P-38K with new Hamilton "paddles" replacing the thick Curtiss blades.

It is surprising that transonic blade profiles from both key manufacturers (Hamilton Standard and Curtiss) improved at all in the meantime, despite the apparent state of awareness of both companies' management. As it was, the adoption of radical new profiles and generally thinner blades moved the limitations and proved a step change in aircraft performance that went largely unremarked upon.

FARNBOROUGH RABBIT-HOLE

Meanwhile, the RAE at Farnborough seemed to disappear down a rabbit hole of "power absorption" and thrust. The concept of "profile power" — the power lost on turning the prop, particularly against Mach effects — is now common currency for rotorcraft, but rarely came up at a time when it may have been most critical. Putting cart before horse, torque was seen as a good thing (i.e. power absorption) as long as thrust ensued. The thinking portrayed by the published reports was very much "little wing", and therefore about lift/drag ratios at higher Mach and not actual rotational moments. In this, the RAE's scientists, who had provided the drag equations that straightened out the A&AEE's power curves, now seemed to be lagging behind the practical engineers.

The RAE's R&M No 2387, on a thick Rotol prop intended for the Spitfire IX, stated:

"At the two higher pitch settings, the tests had to be restricted owing to the severe flutter of the blades . . . As a result, it was not considered

TAH ARCHIVE

ABOVE ***George Brady, Chief Engineer of Curtiss-Wright's Propeller Division, demonstrates a model of a reversible propeller to the Division's Vice-President, R.L. Earle, during the Span of Flight show at Caldwell-Wright Airport in the 1950s. Brady and the propeller industry in general were slow to accept the theories of John Stack and others.***

possible to exceed safely a tip Mach number of about 0·7 at 22° or 0·6 at 27°. Also, the tip Mach number of 0·7 at 22° could only be achieved at tunnel speeds equal to or greater than 120ft/sec [36·6m/sec]."

The "real world" meaning of this — props reacting catastrophically to Mach effects and engines unable to cope — did not seem to register as much more than a frustration to the scientists trying to gather data.

As for de Havilland's Mr Gillmore, who "didn't know his job", in 1941 Kenneth Bryan Gillmore literally wrote the book on blade design with de Havilland Report No 83, something of a "holy grail" for propeller aficionados. He included the effect of compressibility in his equations. He filed a series of airscrew patents, including one for "Improvements in a variable-pitch airscrew-control mechanism" which "locked off" pitch much like the Curtiss prop. As "Pip" Gillmore, he then went on to head Boeing's VTOL tiltrotor programme, which culminated in the V-22 Osprey. There he worked with Leo Dadone, who identified Mach tuck in rotor blades.

Blade Mach tuck, limiting factors on constant-speed systems and high-speed vibration and flutter of propellers seem like three primary reasons why several promising designs famously and unexpectedly failed. The more one applies actual data to specific cases, the more it comes up "propeller" — and the more questionable "received wisdom" becomes.

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VIA AUTHOR

Sabena's Congo Ventilators

INSECT-CONTROL SIKORSKY HELICOPTERS IN AFRICA, 1951–61

The post-Second World War development of the helicopter into a machine uniquely placed to undertake tasks requiring a slow, low flight profile led to a major leap forward in the battle against malaria and other insect-borne diseases. **LEIF HELLSTRÖM** takes a look at Sabena's early use of helicopters for chemical-spraying in the Belgian Congo

CONGOPRESSE VIA AUTHOR

IN TROPICAL REGIONS diseases such as malaria and sleeping sickness have long been a major scourge. When Dichlorodiphenyltrichloroethane, commonly known as DDT, was introduced as an insecticide during the Second World War, it was quickly hailed as a miracle substance and led to the testing of aerial spraying in different parts of the world, including Africa.

"Ventilators" to Congo

In the Belgian Congo (now the Democratic Republic of Congo) some unsatisfactory trials of spraying from an Airspeed Oxford were undertaken in 1947, and it was decided to procure three helicopters for the task instead. The choice of type was limited, but ultimately three Westland-Sikorsky WS-51 Mk 1B Dragonflies were ordered, with the first example delivered in May 1951 and the two others in February 1952. They were registered OO-CWA, 'CWB and 'CWC in the special Congo registry sequence and belonged to the colonial administration, although they were operated by Sabena-Congo. Initially, British pilots were hired to fly the "ventilators", as the helicopters were nicknamed after the local name for a ceiling fan.

Three machines were of course not nearly sufficient to cover the entire country and they were mainly employed in and near the capital, Leopoldville. The insecticide (a solution of DDT or benzene hexachloride — BHC) was carried in external tanks on each side and pumped into the

ABOVE LEFT ***With what might today be deemed shocking disregard for the population on the street below, WS-51 Dragonfly OO-CWC deposits insecticide over an urban neighbourhood in the early 1950s.***
ABOVE RIGHT ***"Hold your noses, boys!" A military camp near N'Dolo Airport in Leopoldville gets a comprehensive dusting by one of the Dragonflies.***

JJ MANS VIA AUTHOR

ABOVE ***Sikorsky S-55A OO-CWG (c/n 55-840) passes overhead trailing a plume of insecticide from its modified exhaust pipe. The long extension was attached to the side of the helicopter's port side and is clearly visible here. The insecticide was fed into the pipe by means of a hose attached to a tank fitted in the S-55A's main cabin.***

UNITED NATIONS ARCHIVE VIA AUTHOR

ABOVE ***The same machine spraying insecticide over Leopoldville in November 1961, by which time it was being used by the World Health Organization as "WHO1", the markings of which are just visible on the ventral fin aft of the cabin. The other two S-55As used by Sabena-Congo were both written off, OO-CWE in 1958 and 'CWF in 1960.***

LEFT ***The wreck of S-55A OO-CWF (c/n 55-839) being dismantled after it suffered a structural failure on the ground near Inga Falls on the Congo River in the west of the country. Among the wreckage in the foreground is the insecticide tank with its feeder hose still attached.***

JJ MANS VIA AUTHOR

BELOW ***A rare colour photograph of one of the three Sabena-Congo S-55As. The trio essentially adopted the same colour scheme as the S-55s used by the airline in Belgium, but with the latter's blue stripe replaced with a green stripe instead.***

engine's extended exhaust pipe for dispersal, the total of some 300lit (66 Imp gal) lasting around 20min. The spraying (or "fogging") brought immediate results, and within a few years the malaria infection rate in children had dropped from almost 100 per cent to eight per cent.

Occasionally the Dragonflies were used for other duties than pest control but the type had a very limited load-carrying capability. The Mk 1B, with its 450 h.p. Pratt & Whitney Wasp Junior engine, was particularly underpowered for the hot climate and by 1953 it had been decided to replace the WS-51 with the Sikorsky S-55.

In March 1955 three new S-55As, registered OO-CWE, 'CWF and 'CWG, arrived as replacements and the WS-51s were sold to new owners in the USA. The S-55As were also operated by Sabena-Congo and used in much the same way, although with better payload, range and overall flexibility. The insecticide was now carried in a detachable tank in the cabin. But, despite its 800 h.p. Wright Cyclone engine, the S-55A was still underpowered for the Congo and needed to make a rolling take-off when heavily loaded.

The helicopters were sometimes also used in the French Congo, and on January 27, 1958, OO-CWE crashed 25km (15 miles) south-west of Mossendjo. The two crew members and three passengers were all killed. The remaining S-55As continued to serve until April 1, 1960, when they were officially transferred to the *Force Publique*, or local armed forces. They were still used for spraying, however, and during a mission on April 4 'CWF was damaged beyond economical repair on the ground at Inga in the Lower Congo, when the tail rotor sheared off the boom.

In the chaos that followed independence on June 30, 1960, the last S-55A was abandoned at Leopoldville as the Belgian crews left. It was briefly resurrected in November 1961 by the World Health Organization, marked "WHO1" and flown by Swedish United Nations pilots over Leopoldville. But in February 1962 the helicopter was handed over to the Congolese Air Force where it soon languished, ending this unusual chapter in aviation history.

ANDRÉ CAUVIN / CEGES VIA AUTHOR

THE PATAGONIAN EAGLE

ARGENTINA'S INSTITUTO AEROTÉCNICO IAE.30 ÑANCÚ: THE FULL STORY

Bearing a striking resemblance to de Havilland's D.H.103 Hornet, Argentina's IAe.30 Ñancú had much in common with its British "hot-rod" inspiration, including the same Rolls-Royce engines. After more than a decade of in-depth research into the type and its development, **RICARDO M. LEZON & SANTIAGO RIVAS** provide the most detailed history of the type yet published

TAH ARCHIVE

RIGHT ***The IAe.22 DL two-seat trainer was the first aircraft to be developed under the leadership of the*** **Instituto Aerotécnico's** ***Juan Ignacio San Martín. Powered by an indigenous IAe.16 El Gaucho nine-cylinder air-cooled radial engine, the first nationally designed aero-engine, the prototype made its first flight on May 25, 1943. Around 200 were built, the type seeing service with the Argentinian Air Force and Navy.***

MAIN PICTURE ***Showing its sleek lines and prominent nacelles housing its Rolls-Royce Merlin 130-series engines, the IAe.30 Ñancú prototype is seen here at the IAe factory at Córdoba in central Argentina.***

JUAN-CARLOS CICALESI VIA AUTHORS

FOLLOWING THE ESTABLISHMENT of Argentina's *Fábrica Militar de Aviones* (FMA) in October 1927, the manufacturer undertook numerous aircraft projects, some of indigenous design and others built under licence. FMA was reconstituted as part of the *Instituto Aerotécnico* (IAe) on October 20, 1943. The company entered the modern age, however, with the appointment of *Comodoro Ingeniero* Juan Ignacio San Martín as Director of the IAe on March 6, 1944. San Martín's extraordinary vision and drive led to the establishment of a slew of progressive projects and the dawning of a golden age for Argentina's aviation industry.

POST-WAR RENAISSANCE

The IAe's first venture under San Martín's leadership was the IAe.22 DL, an advanced monoplane trainer built entirely of wood, somewhat similar in general appearance to the North American NA-16. On July 4, 1946, the IAe.24 Calquin light bomber prototype made its maiden flight, with *Jefe de Pilotos de Prueba del Instituto Aerotécnico* (IAe Chief Test Pilot) *Capitán* Osvaldo M. Rovere at the controls and San Martín as flight observer.

An important aspect of aeronautical work in Argentina at this time was the research and development of substitute materials, as non-locally-produced strategic materials were impossible to procure owing to war restrictions. The IAe therefore had to develop new methods to manufacture aircraft plywood, special alloys, glues and resins.

By mid-1946 the IAe was the largest industrial establishment in Argentina, employing 22 aeronautical engineers, 38 industrial engineers, 23 sub-engineers, 134 draughtsmen and nearly 3,000 specialised workers, plus administrative staff. The IAe factory at Córdoba boasted state-of-the-art machinery and had extensively equipped laboratories, capable of being used for any industrial project. This reorganisation and expansion of the factory and resulting increase in the quantity and quality of its facilities could not have been achieved without improving the technical level of its engineering staff, however. This was achieved owing in part to the incorporation of a group of professionals hired in former Axis countries, thanks to the remarkable work of the *Delegación Argentina de Immigración Europea* (Argentinian European Immigration Delegation) which, since 1946, had competed against American, British and Soviet recruiters to establish contacts with professionals in Germany and Italy, convincing them of a rosy future in a neutral, prosperous new home far from the ruins of their home countries. The Delegation worked closely with Argentinian embassies in Europe, mainly in Rome and Madrid.

TAH ARCHIVE

ABOVE ***At first glance looking very much like a radial-engined de Havilland Mosquito, to which it owed a clear design debt, the IAe.24 Calquin (Royal Eagle) was in fact slightly smaller, with a span of 16·3m (53ft 6in), as against the Mosquito's 16·51m (54ft 2in), and a length of 12m (39ft 4in) to the British type's 13·56m (44ft 6in). It was planned to put Merlins on the Calquin as the IAe.28, but the Ñancú was developed instead.***

RICARDO BURZACO VIA AUTHORS

RIGHT Teniente Primero ***Edmundo Osvaldo Weiss (left) and Cesare Pallavicino pose for a photograph in front of the IAe.30 prototype. Having designed aircraft for Breda and Caproni in Italy before the war, Pallavicino co-designed the Lambretta motor scooter before emigrating to Argentina in 1946.***

In the spring of 1946 *Brigadieres* Bartolome de la Colina and San Martín arrived in Europe to oversee the programme, hiring several top-flight engineers including Germans Reimar Horten and Kurt Tank, Emile Dewoitine in France and Cesare Pallavicino in Italy, all of whom went to Argentina with their own teams of technicians.

MERLINS FOR THE CALQUIN

The poor perfomance of the Calquin led to the initiation of the IAe.28 project, intended to succeed the Calquin on the production lines. The *Secretaria de Aeronautica* 1946 official records describe the IAe.28 project thus:

"Study; project and construction of a fighter and light bomber using native woods . . . started during 1946; consisted mainly of designing and building an aircraft based on IAe.24, modifying its structure in such a way as to allow the incorporation of Rolls-Royce Merlin 604 liquid-cooled engines, [thus providing] performance and characteristics superior to those of the Calquin with Pratt & Whitney R-1830-65A engines.

"The type of construction is similar to that of the Calquin, differing in modifications for the incorporation of the new engines [and incorporating] fully metallic, movable control surfaces to prevent deformation; [also] adaptation of the radiators on the leading edge of the wing [and] a new undercarriage; [an] increase in fuel capacity and total change of fuel and oil circuits. Also, modifications aimed at improving ease of maintenance that experience revealed during use of the Calquin have been introduced."

Accordingly, Merlin powerplants were sent from Rolls-Royce's UK factory in Derby during June 21–29, 1946.

In late 1946 Cesare Pallavicino, who had been in Argentina since the summer, along with a large group of Italian technicians and craftsmen mainly from the Caproni Cantieri workshops, assumed the technical directorship of the IAe. Meanwhile, San Martín was put in charge of national aircraft production and set about preparing a vast production programme, on which the Italian technicians and workers would co-operate.

Pallavicino was assigned to *Grupo División*

LEFT ***The prototype IAe.30 Ñancú under construction in the IAe hangar at Córdoba in the second half of 1947. This aircraft reportedly took more than 370,000 man-hours to build, but was completed in a remarkable 11 months.***

J-C CICALESI VIA AUTHORS

BELOW ***The prototype in bare metal, with early canopy, soon after completion at the IAe factory at Córdoba. The prominent Merlin 130-series engines were designed as "slimline" variants with minimal frontal area specifically for the D.H.103 Hornet.***

*de Tareas Especiales No 2 (*Special Tasks Division Group No 2), formed on June 5, 1947, as part of the IAe. The unit comprised four engineers and a dozen designers, the latter ultimately proving unsuitable for the task. Pallavicino solved the problem by replacing them with four Italian designers used to his working methods. He also invited students from the technical school at Rosario in Santa Fé Province to join his team. During his stay in Argentina, Pallavicino also taught radio and aeronautical engineering at the Universidad de Córdoba.

THE EAGLE RISES

In early 1947 the *Fuerza Aérea Argentina* (FAéA — Argentinian Air Force) HQ issued a specification for a heavily armed single-seat day- and night-fighter. Pallavicino responded with preliminary drawings for a twin-engined monoplane fighter incorporating the most heavily concentrated mounting possible for four 20mm cannon, a good all-around view for the pilot and a minimum-drag airframe. The design received the official designation IAe.30 Ñancú (Patagonian Eagle).

The new type was a good example of the high standards obtainable with close collaboration between aircraft designer and powerplant manufacturer, although sound basic design foundations are vital if extensive developments are planned. When the design of the IAe.30 was put forward in February 1947 the decision was made to use Rolls-Royce's Merlin 130 series of powerplants. The Merlin 134/135 was a variant specially developed for installation on the de Havilland D.H.103 Hornet, the first twin-engined British military aircraft to have "handed" (i.e. counter-rotating) propellers.

On March 17, 1947, Pallavicino submitted drawings of a jet variant of the IAe.30. This "Jet Ñancú" was to be powered by two Rolls-Royce Derwent V centrifugal-flow turbojet engines, each of 3,500lb (1,590kg)-thrust. Adapting the Ñancú to jet power would require considerable modifications but produced a slim, elegant aircraft. The taildragger undercarriage configuration was changed to a tricycle arrangement and the fin and rudder were also modified.

By June 1947 progress on the IAe.28 Merlin-powered Calquin was well advanced, but little enthusiasm was felt for it by the IAe, which turned its attention to the IAe.30 instead, and the IAe.28 project was cancelled.

The IAe assigned construction number IA 30/MD/01 to the IAe.30 Ñancú protoype, the FAéA

ROLLS-ROYCE HERITAGE TRUST VIA TONY BUTTLER

PHILIP JARRETT COLLECTION

Clearly the inspiration for the Ñancú in the same way the Mosquito had been for the Calquin, the de Havilland Hornet was initially designed as a fast, agile single-seat fighter with long range, capable of taking on single-engined Japanese fighters in the South Pacific. This F.3, PX386, was flown by Edmundo Weiss at Hatfield in 1947 and is seen here at the UK National Air Races at Elmdon in 1949.

J-C CICALESI VIA AUTHORS

RIGHT ***Edmundo Weiss (furthest right) with de Havilland personnel, including test pilot Geoffrey Pike (second from left), beside PX386 at the company's airfield at Hatfield in 1947. Weiss was despatched to the UK to familiarise himself with various types of state-of-the-art fighters, particularly the Hornet, which would provide a good grounding for flying the Ñancú.***

assigning it military serial I-101, although the latter was never applied. On July 10, 1948 (not the 9th as sometimes stated), the prototype was rolled out for systems and fuel-flow checks, engine-runs and taxying trials, the latter including undercarriage adjustments and take-off-run estimates. Following these trials, IAe technicians examined the aircraft, finding a fault with the undercarriage retraction system. After adjustments, the aircraft was declared fit to fly.

The following day the local press announced the roll-out of the new fighter. Three photographs and a short description were published in the *Diario Democracia* newspaper, which described the Ñancú as one of Argentina's fastest aircraft and informed readers that its latest Rolls-Royce Merlins produced 1,800 h.p., capable of taking the machine to 435 m.p.h. (700km/h) at 27,500ft (8,400m). It stated: "This technical and industrial effort will place the local aeronautical industry at the forefront by matching the performance of the de Havilland Hornet, rightly marked as the fastest ever piston-engined fighter".

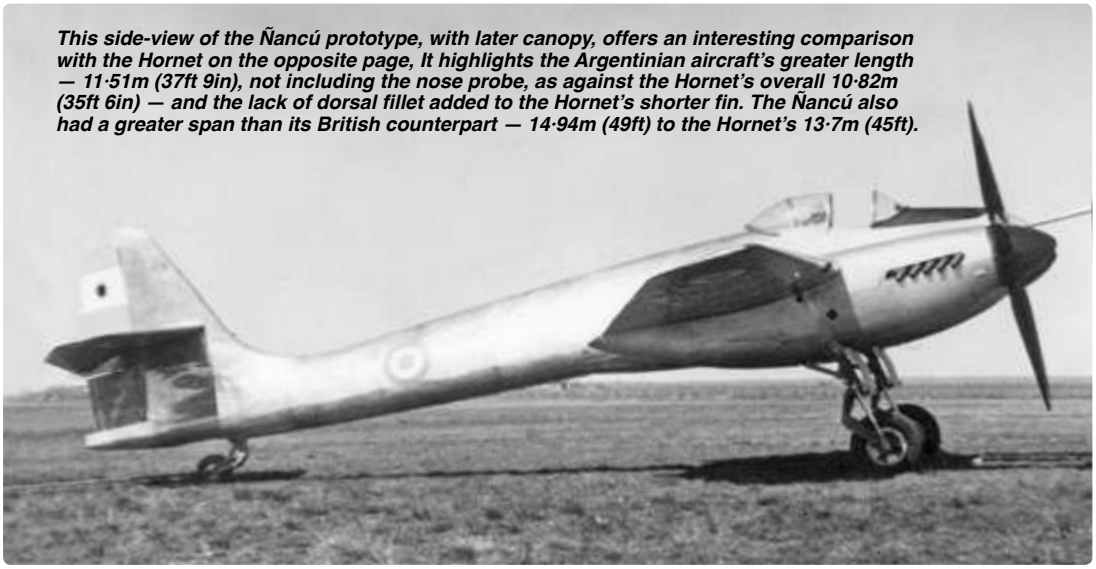
FIRST FLIGHT

Early on the morning of July 18 (some sources say 17th), the Ñancú prototype, in natural metal finish, sat outside the IAe hangar undergoing final preparations for its maiden flight. The pilot was the IAe Chief Test Pilot *Primer Teniente* Edmundo O. Weiss, who had been sent to the UK the previous year to evaluate various aircraft, including Hornet F.3 PX386 at Hatfield.

The IAe technicians began their external checks of the Ñancú, starting with the cockpit and working around in a clockwise direction. Meanwhile, another group checked the Merlins' fuel, oil and glycol coolant levels, exhaust manifolds and intercoolers. With the airframe, undercarriage, radiators and cockpit inspected and flying controls tested, IAe technicians started the engines and checked the magnetos, engine temperatures and various power settings.

After brief preliminaries, Weiss climbed into the cockpit, strapped in and, satisfied that all was as it should be, signalled that he was ready to go. The groundcrew pulled the chocks away from the mainwheels, the throaty Merlins driving their massive 12ft (3·6m)-diameter de Havilland propellers. Giving a burst of power, Weiss taxied the prototype smartly to the end of the airfield — the "ready to boil" Merlins warmed up quickly and it was recommended that the aircraft be faced into wind during all ground running.

On the far side of the airfield, the Ñancú moved forward, speeding across the grass into the wind with its tail up. It did not leave the ground,



This side-view of the Ñancú prototype, with later canopy, offers an interesting comparison with the Hornet on the opposite page, It highlights the Argentinian aircraft's greater length — 11·51m (37ft 9in), not including the nose probe, as against the Hornet's overall 10·82m (35ft 6in) — and the lack of dorsal fillet added to the Hornet's shorter fin. The Ñancú also had a greater span than its British counterpart — 14·94m (49ft) to the Hornet's 13·7m (45ft).

however, and Weiss brought the prototype back to the end of the runway. There was nothing amiss; Weiss had raced across the airfield with both Merlins at full power to sample fore-and-aft control. He was satisfied. Again the Ñancú began to move forward. At 1100hr Weiss lifted the machine into the air after a 900ft (280m) run, to begin a 20min test flight, during which a speed of 230 m.p.h. (370km/h) was attained. An undercarriage retraction-system issue persisted, however, and Weiss elected to land at the airfield of the *Escuela Militar de Paracaidistas*.

The IAe.30 had gone from drawing board to first flight in just 11 months, thanks to the foresight, skill and initiative of Pallavicino, ably assisted by engineers Gaviraghi and Ferretti, technicians Pietro Montano, Quarti (a former Caproni designer), Targhi, Bardi, Trabalza, Fossatti, Cerrutti, Pastorino, Saldin and Moldano, plus some 60 specialist Italian workers. The aircraft's maiden flight was covered by the main local newspapers, although unfortunately their efforts were largely ignored at a national level.

Five further flights of the prototype were undertaken during July 18–30, during which it was reported that it was impossible to retract the undercarriage. In addition, the ailerons were reported as being overly heavy. Adjustments were made to solve the undercarriage problem and the aircraft was made ready to send to Buenos Aires.

PUBLIC DEBUT

In August 1947 the Argentinian government announced that a display of new aircraft was to be held at the Aeroparque in the capital. Exhibits were to include the IAe.27 Pulqui I jet fighter, Ñancú prototype and the Vickers Viking T.1 recently ordered for President Perón. On August 8, the gleaming Ñancú prototype sat on the ramp at the IAe factory awaiting its pilot.

At 1200hr, after charts and logsheets had been prepared and preliminary checks completed, Weiss climbed into the cockpit, completed final checks, ordered chocks away and taxied to the end of the airfield. At 1320hr he took off for Buenos Aires. Flying at 18,700ft (5,700m) with the throttle set at 60 per cent power, he covered 400 miles (643km) in 55min at an average speed of 404 m.p.h. (650km/h), with peaks of 485 m.p.h. (780km/h) owing to a strong tailwind.

At 1415hr a sleek silver form was visible approaching the Aeroparque from the north-west. Initially flying over the Aeroparque at 5,000ft (1,500m) at around 300 m.p.h. (480km/h), the aircraft approached the control tower at 2,000–3,000ft (600–900m) at high speed before turning so tightly that vapour trails streamed from the wingtips; it then flew a circuit and landed.

Weiss emerged from the tiny cockpit of the Ñancú and climbed down the ladder to be hailed as a hero by *Secretario de Aeronáutica* Brigadier César R. Ojeda and San Martín. The following day, the Ñancú and Pulqui I were displayed for President Perón, his wife Eva Duarte de Perón, Ojeda and his staff, San Martín, Pallavicino, *Ejército Argentino* (Argentinian Army) officers, British Air Attaché Air Cdre Henry Edward Walker, British Civil Assistant Air Attaché R.H. Van Dyke and Argentinian government representatives. After the flying display, Weiss, Pallavicino and Ferretti were presented to Perón, who congratulated them for the success of the flight and awarded a medal to Pallavicino for his contribution to the nation's aviation industry.

The Ñancú evidently made a good impression, as the following day the Argentinian government placed an order for 210 examples of the type, with instructions for extensive production. It was obvious that the IAe.30 was something of a "hot

Continued on page 88

ANATOMY OF THE EAGLE THE IAE.30 ÑANCÚ DESCRIBED

THE STREAMLINED semi-monocoque fuselage was designed in two primary sections, front and rear, the latter including the integral fin. Designer Cesare Pallavicino adopted the "pear-shaped" triangular cross-section used in his Caproni Ca 331 twin-engined monoplane light-bomber.

Wings
The IAe.30's wing was a one-piece cantilever structure incorporating two spars. The wing's taper was kept as sharp as possible to conserve the aircraft's roll performance and the tip was squared to permit the aileron to extend outboard as far as possible, again to enhance roll quality. The control surfaces were metal-covered; Alclad ailerons and hydraulically-operated split flaps, divided by the engine nacelles, were fitted.

Empennage
The tailplane and fin were cantilever all-metal structures incorporating two spars. The fin was integrally built with the fuselage. The rudder and elevators had controllable and automatic trim-tabs.

Undercarriage
The undercarriage consisted of two retractable single mainwheel units, one under each engine nacelle, and a retractable tailwheel. The mainwheel forks were fitted with oleo-pneumatic shock absorbers. The mainwheels rotated through 90° when raised, to lie flat in the engine nacelles. Dunlop brakes and AH8208 wheels were fitted. The tailwheel was also supplied by Dunlop and used a rubber-in-compression shock absorber.

Powerplant
The IAe.30 was powered by two liquid-cooled V12 Rolls-Royce Merlin 134-5/135-5s, fitted with Corliss throttles to give less throttle torque and a clean intake at full throttle conditions. Four engines were purchased for the Ñancú prototype and two "power egg" installation units were also obtained. The four engines were de Havilland Hornet examples built and converted at Derby. The suffix -5 denoted the customer, Argentina's *Instituto Aerotécnico*. Originally manufactured by Rolls-Royce at its Derby works as Merlin 130s (c/ns 234729 and 234799) and 131s (c/ns 236702 and 236026), the four engines were converted to 134/135s under Contract No 479, dated March 25, 1947. On completion of tests, the engines were renumbered, packed in crates and readied for shipment. Merlin 134-5s Nos 309001 and 309003 were despatched on May 23, 1947, the Merlin 135-5s Nos 309002 and 309004 following exactly a week later. These were two-stage, two-speed units with supercharger and intercooler, using a downdraught air intake and reverse coolant flow and both were mounted in "power egg" nacelles. The Merlin 134-5 had a reverse-rotating propshaft, and both engines drove four-bladed de Havilland Hydromatic 4/4000/5 constant-speed narrow-chord fully feathering propellers of 12ft (3·6m) diameter.

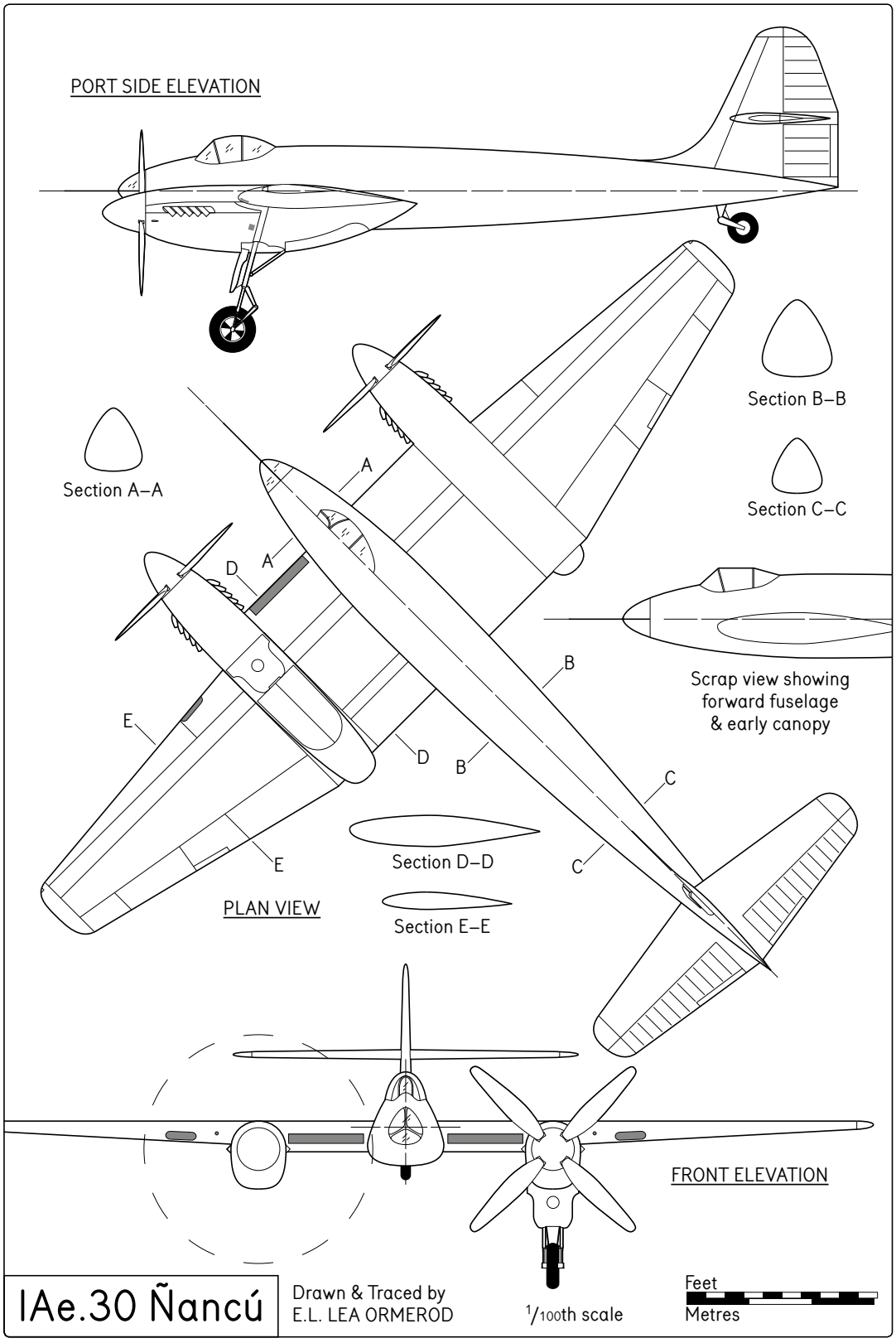
The engines were mounted low to obtain a smooth airflow over the wing, with their exhausts ejecting below; the positioning of the nacelles allowed for a relatively short undercarriage main leg for easy stowage when retracted, and gave the pilot a completely unrestricted view over the top surface of the wing. The engines were mounted on steel-tube frames attached to the front spar and to the undercarriage fixed structure. The coolant radiators and oil coolers were housed within the forward section of the wing profile between the fuselage and each engine nacelle. Temperature was thermostatically controlled and the carburettor air intake was ducted from an opening in the leading edge of each wing outboard of the engine.

Fuel
The fuel load comprised four pairs of wing tanks and two fuselage tanks. All were self-sealing and vented to atmosphere. Each pair of wing tanks was interconnected, with one pair of tanks outboard and one inboard of each engine.

Communications & navigation equipment
Collins AN/ART 13 radio transmitter and Bendix MN 31 radio compass.

Armament
An alternative gun arrangement was examined. The original proposal had four 20mm Hispano-Suiza HS 804 cannon mounted in the lower fuselage nose. In addition, a 250kg (550lb) bomb could be carried under the fuselage or five 83mm rocket projectiles could be fitted under the outer wings. The prototype was never armed. **RML & SR**

ABOVE ***A view inside the slim and elegant "pear-shaped" curved-triangular-section fuselage of the prototype during construction. The structure was conventional, comprising alloy frames and top-hat-section stringers, to which the outer Alclad skin was riveted.***


PORT SIDE ELEVATION
Section A–A
Section B–B
Section C–C
Scrap view showing
forward fuselage
& early canopy
A
D
A
B
E
D
B
C
E
C
Section D–D
Section E–E
PLAN VIEW
FRONT ELEVATION
IAe.30 Ñancú
Drawn & Traced by
E.L. LEA ORMEROD
1/100th scale
Feet
Metres

The prototype with FAéA roundels added, but without its military serial, I-101, which was never applied to the aircraft. The glazed nose and long probe were fitted for the trials programme, but would have been replaced on production examples with a solid nose and a quartet of Hispano-Suiza 20mm cannon. Note also the radiator- and oil-cooler intakes in the wings inboard of the engines; the carburettor intakes were in the outer wings.

J-C CICALESI VIA AUTHORS

RIGHT ***A ½₄th-scale wooden model of the IAe.30 discovered by author Ricardo Lezon during a visit to Córdoba in 2013. It is not a windtunnel model, as no such testing was undertaken on the design, so it is thought to be a model of the prospective production version, with a solid nose, reshaped canopy, and with evidence that a dorsal fillet was also to be fitted.***

RICARDO M. LEZON

Continued from page 85

rod". Accordingly, the IAe began negotiations with Rolls-Royce for 430 engines plus spares.

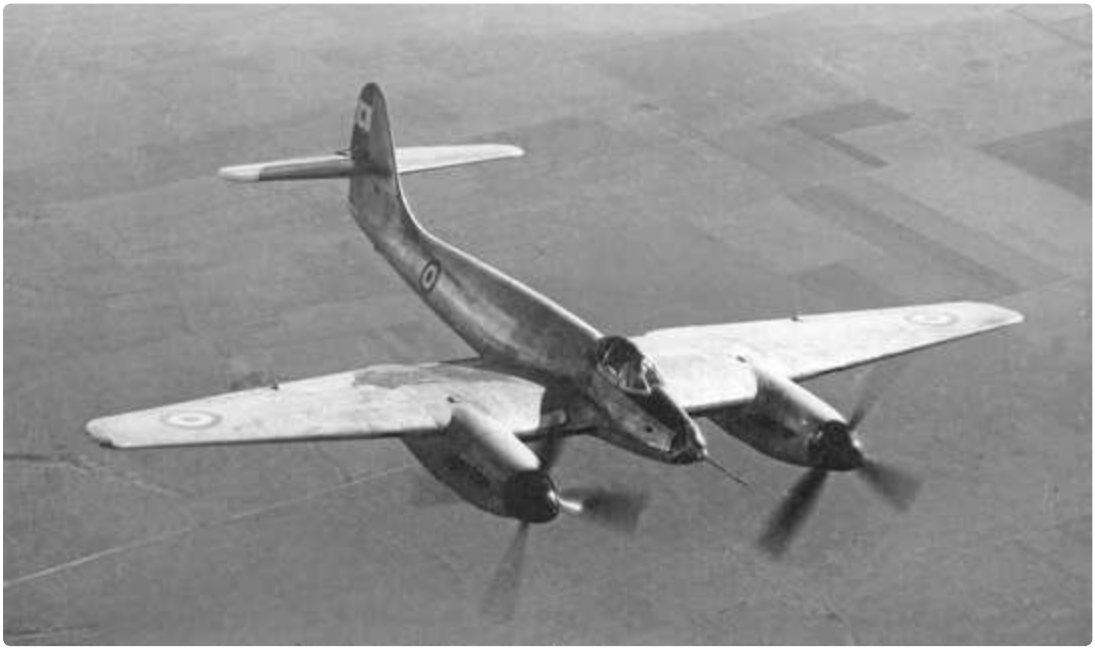
TO THE UK?

Owing to the aircraft's outstanding performance, the Argentinian government, always alert to the value of propaganda, asked Pallavicino to take the aircraft to Europe and display it there. The prospective trip would coincide with the first show to be held at Farnborough by the Society of British Aircraft Constructors (SBAC), during September 7–12, 1948. At this time all aircraft displayed at an SBAC show had to be manufactured in the UK or be powered by a British engine. The IAe.30 therefore had the opportunity to be one of the first foreign aircraft to be displayed at an SBAC show.

The first leg of the flight to the UK was to be from Buenos Aires to Rio Janeiro and Natal in Brazil, to Dakar in Senegal via the Canary Islands and finally on to the UK. The normal fuel load of the Ñancú was 655 Imp gal (2,978lit), giving a range of 1,678 miles (2,700km). Since the distance from Natal to Dakar was 1,865 miles (3,000km), a 135 Imp gal (614lit) tank was fitted in the fuselage, making a total fuel load of 792gal (3,600lit) which provided a range of 2,232 miles (3,592km).

Two FAéA Avro Lancastrian IVs, serials T-65 and T-66 (formerly LV-ACV and LV-ACU respectively of *Flota Aérea Mercante Argentina*), were assigned to assist the prototype en route, and one was used to assess fuel consumption during the proposed ferry flight. On August 17, 1948, T-65 was flown from Córdoba to Morón airport to be readied for the long flight to Dakar. Taking off from Morón the next day, the Lancastrian, crewed by Capt L.A. Lafuente (Commander), Capt J.C. Villa (First Pilot), *Alférez* L.A. Castagnino, *Suboficial Auxiliar* R.A. Bolla (mechanic) and Suboficiales Auxiliares B.A. Garcia and B.A. Iñon (wireless operators), reached Natal in a flight time of 11hr 5min. On August 20 the Lancastrian flew 1,865 miles from Natal to Dakar in 8hr 30min piloted by *Premier Teniente* S. Posadas. The return flight to Natal on August 22 took 7hr 55min, with the last leg back to Morón completed in 13hr the following day.

On their return to Córdoba the crew of T-65 set about preparing operational procedures based on the information gathered from the trip, including technical detail and fuel consumption.



ARCHIVO GENERAL DE LA NACIÓN

ABOVE ***On its return from Bolivia some modifications were made to the Ñancú prototype. The original one-piece windscreen was replaced with a flat armoured front windscreen with two Perspex side panels. Aileron control was extremely heavy at high speeds and spring-tabs were fitted to provide improved lateral control at speeds up to the maximum permissible.***

Although a presidential government decree dated September 6, 1948, provided official authorisation for the UK visit, it was cancelled owing to a lack of time to prepare the aircraft fully. Also, Pallavicino was strongly opposed to the plan. He considered the aircraft to be unready and was adamant that the pilot selected would need advanced navigation training. Unfortunately, Pallavicino became embroiled in a disagreement with the IAe management and lost his position as Director; instead he was assigned to oversee the development of the prototype and the type's mass production.

TESTING TIMES

IAe test pilots *Teniente* Luis Valoni and *Sub-Oficial* Jorge Villegas performed test flights, supervised by Weiss. Some of the snags encountered on the first flight still remained to be overcome in September 1948, when the aircraft was sent to Córdoba for brief handling trials by the IAe pilots. The latter reported favourably on the Ñancú's handling but criticised the heaviness of the controls in all three axes of flight at high speed, and lack of balance in the ailerons.

By early September 1948 the prototype had completed 34 flights. On September 10 the aircraft was flown at the IAe by Kurt Tank, the German designer famous for his exceptional wartime Focke-Wulf Fw 190 fighter, who checked the aircraft's handling characteristics. At 1350hr Tank climbed into the crisp winter air in the prototype, and spent 50min checking the aircraft's performance. The resulting report, addressed to Pallavicino, agreed with previous criticisms and was negative about the instrument layout among other things (see panel on page 91).

In October 1948 the Bolivian government announced that a *Feria Industrial Internacional* (International Industrial Fair) was to be held at El Alto (La Paz) to commemorate the city's 400th anniversary. Several nations were invited to participate, including Argentina. The latter's government, eager to show its new state-of-the-art aircraft, set out a plan to send a delegation of IAe representatives and the Ñancú to Bolivia to be displayed to potential buyers, while also evaluating the aircraft's suitability for Bolivia's demanding operational requirements.

Following the completion of a major overhaul and test flight of the Ñancú, Edmundo Weiss set off for El Alto, accompanied by the IAe delegation in FAéA Douglas C-47 serial T-20. At 1100hr on November 4, 1948, Weiss took off at El Alto and performed his display according to his flight plan. Having completed the official demonstration, Weiss added two more display items to his routine, making a low pass with the undercarriage extended and another with one propeller feathered. He then climbed into the clouds, only to reappear in a full-power dive aimed directly at the grandstand, during which he set a new speed record for a twin-piston-engined aircraft, the Ñancú reaching a blistering 550 m.p.h. (885km/h). After Weiss had landed, everybody wanted to meet the brave pilot. As for the evaluation of the type in Bolivia's

A fine air-to-air study of the prototype over the Sierras Chicas mountains while up on a test flight from Córdoba. Of particular note in this view is the much higher-set tailplane of the Ñancú compared to the Hornet, the tailplane of which was in a more conventional position at the base of the distinctive de Havilland fin.

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J-C CICALESI VIA AUTHORS

LEFT ***A full-scale mock-up of the production version of the IAe.30 in the hangar at Córdoba, incorporating design revisions including a solid nose, a lower-set tailplane and a dorsal fillet similar to that of the Hornet, plus a single-piece rudder and the reconfigured cockpit canopy.***

BELOW ***The prototype warms up at Córdoba for another test flight. Although the Ñancú was unquestionably a promising design and a remarkable achievement for a relatively inexperienced industry, it was developed at a time when the future of fighters was inevitably jet-powered.***

J-C CICALESI VIA AUTHORS

KURT TANK'S REPORT ON THE ÑANCÚ, SEPTEMBER 10, 1948

ON SEPTEMBER 10, 1948, German expatriate designer Kurt Tank (**BELOW**) flew the IAe.30 Ñancú prototype to assess its performance and handling characteristics. Excerpts of his report are included below.

"The arrangement of instruments and throttle levers does not correspond to the requirements of a modern fighter. A complete revision is required. Taxy and take-off is normal and there is no swing, thanks to the counter-rotation of the propellers.

"Deficient harmonisation of rudder and elevators was evident once the aircraft gained speed after retracting the undercarriage. The forces of the elevators and rudder remained within limits, while the aileron forces increased excessively, so that actuation at 300 m.p.h. [483km/h] was hardly possible. A turn to the left couldn't be stabilised immediately, as the Flettner [servo] tab control was misplaced to touch. Also, the effectiveness of stabilisation is very low. The aircraft was stabilised with the use of the entire deviation margin.

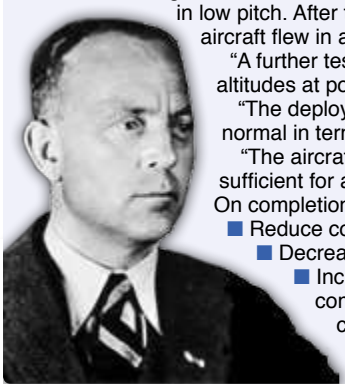
"After achieving equilibrium in the three axes, the stability conditions were provisionally evaluated at 8,200ft:

Vertical axis The return to the normal position is aperiodic after applying a strong stick force;

Lateral axis The aileron control is heavy at high speed. The aircraft recovered slowly but unequivocally after each turn keeping the stick fixed. This test must be repeated with aileron-control forces corrected;

Longitudinal axis There is sufficient static and dynamic longitudinal stability at the centre of gravity.

"After throttling back, the aircraft maintained direction through slight stick movements, even with the propeller in low pitch. After trimming the aircraft around the vertical axis applying the Flettner tab, the aircraft flew in a straight line.



"A further test showed that height can easily be maintained on either engine at moderate altitudes at power well within the weak-mixture range.

"The deployment of the undercarriage was fast and the reaction of the aircraft was normal in terms of longitudinal inclination when lowering the flaps.

"The aircraft's behaviour during landing is normal and the efficacy of the elevators is sufficient for a three-point landing."

On completion of the test flight, Tank recommended the following modifications:

- Reduce considerably the force of the ailerons and harmonise them with the elevators;
- Decrease sensitivity of compensation, to improve stability;
- Increase the sensitivity of the aileron control or reverse the direction of command of the servo tab. After this modification, the speed must be considerably increased during the test, in order to allow the necessary harmonisation of the control forces. **Compiled by RML & SR**

demanding *altiplano* (high plain) environment, with elevations of 13,500ft (4,100m), the Ñancú's performance proved to be exceptional.

OUT OF TIME

After its return from Bolivia, some modifications were made to the prototype, including the replacement of the original one-piece windscreen with a flat armoured front windscreen with two curved Perspex side panels. Aileron control was still deemed to be extremely heavy at high speed so spring-tabs were fitted in order to provide improved lateral control at speeds up to the maximum permissible. Brief handling trials were undertaken to investigate the effect of the spring-tab ailerons on the aircraft's handling characteristics, during the course of which some simple measurements were taken in order to compare with earlier control-load measurements. The spring-tabs brought about a considerable improvement, chiefly in rate of roll at high speed. The original Perspex nosecone and large probe for trials were retained.

Meanwhile, the second prototype was taking shape on Pallavicino's drawing board. A full-scale wooden mock-up was built incorporating a number of design revisions, including a solid nose to house the Hispano cannon plus 760 rounds of ammunition as well as a lower-set tailplane and an extended dorsal fin, which would be beneficial at low speed in an engine-out situation, a single-piece rudder and a reshaped canopy.

With these improvements the aircraft was deemed satisfactory, with prospective improved manœuvrability and overall performance, especially on take-off and landing. Ground handling proved to be easy. It was determined that the improved Ñancú would meet the FAéA's needs. In early April 1949, however, Rolls-Royce informed the Argentinians that it would not be able to meet the supply demands of the IAe for Merlins, although the British company went on to sign a lucrative contract for the Argentinian licence-building of its Derwent jet, plus the supply of machine tools to manufacture it.

In the meantime, the Ñancú prototype continued flying well into 1951. It last flew in November that year, when trials were brought to an abrupt halt when IAe test pilot Capt Carlos Fermin Bergaglio took the aircraft for a flight test; on final approach, he realised he had misjudged his height and was too high. He subsequently failed to add power in the flare. The aircraft stalled and cartwheeled into the ground. Happily, Bergaglio suffered only minor injuries.

By this point, progress on the IAe.33 Pulqui II jet fighter was at an advanced stage. The authorities reviewed the IAe.30 programme and, realising that jet fighters were the future, cancelled all further development on the type. Sadly, the Ñancú

MICHAEL MAGNUSSON VIA AUTHORS

VIA AUTHORS

ABOVE ***A sad end for the sole Ñancú — after*** **Capitán** ***Carlos Fermin Bergaglio's landing accident in November 1951, the aircraft's remains were dragged to a corner of the airfield at Córdoba and left to rot into the weeds before finally being scrapped.***

LEFT ***The last remaining souvenir of the IAe.30 Ñancú — a sectioned example of one of its two Rolls-Royce Merlin 130-series engines — remains on display at the*** **Museo Universitario de Tecnología Aeroespacial** ***in Córdoba, along with a model of the aircraft.***

went from a cutting-edge fighter at its conception to a disabled carcass on a forgotten part of the IAe airfield. Following the removal of any useful components, the sole prototype was towed away and scrapped, although one of the engines was sectioned and put on display in Córdoba's *Museo Universitario de Tecnología Aeroespacial*.

The Ñancú had a lot of potential, so it will come as no surprise that there were several proposed developments of the type. Pallavicino left Argentina in the spring of 1950, but before his departure he submitted two preliminary drawings for single- and two-seat variants, both to be powered by a pair of Derwent V engines. Some of these drawings reveal previously unknown concepts, such as a variant with swept wings dated April 21, 1949. Unfortunately there is little in the way of hard documentation to supplement these drawings.

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IAE.30 ÑANCÚ DATA

Powerplant 2 x Rolls-Royce Merlin 130-series (134-5 port, 135-5 starboard) 12-cylinder liquid-cooled piston engines providing 2,035 h.p. at 2,000ft (600m) using 130-octane fuel at +25lb/in² boost, each driving a four-bladed de Havilland variable-pitch propeller

Dimensions		
Span	14·94m	(49ft 0in)
Length (fuselage)	11·51m	(37ft 9in)
Height (over tail in flying position)	5·16m	(16ft 11in)
Wing area	35·3m²	(380ft²)
Weights		
Empty	5,575kg	(12,290lb)
Loaded	8,746kg	(19,260lb)
Maximum take-off	8,754kg	(19,300lb)
Fuel		
2,978lit (655 Imp gal) + 614lit (135 Imp gal) in extra fuel tank		
Performance		
Maximum speed	780km/h	(485 m.p.h.)
Cruising speed	500km/h	(311 m.p.h.)
Range	2,700km	(1,680 miles)
with extra fuel tanks in fuselage	5,000km	(3,100 miles)
Service ceiling	8,000m	(26,000ft)
Rate of climb	660m/min	(2,160ft/min)

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MAJOR SU SAMPONG:

ON THE WINGS OF THE HANSA

Flying with the Cambodian air arm, 1960–75 / Part 3

ALBERT GRANDOLINI concludes his three-part profile of the eventful flying career of the late Major Su Sampong, a Cambodian military pilot who served with the nation's air arm during its most turbulent period. We rejoin the Major in 1973 as the political situation in Cambodia deteriorates, leaving him and his fellow pilots facing an increasingly bleak future

ON MARCH 17, 1973, Captain So Potra, husband of one of the exiled Prince Norodom Sihanouk's daughters, bombed the Presidential Palace in Phnom Penh in a Khmer Air Force (KAF) T-28D; but the President of the Khmer Republic, General Lon Nol, was absent. The pilot landed at an airstrip in a communist-controlled area near Kratié. As a result, the KAF commander, Brig-Gen So Satto, was removed from his post and sent to Washington DC as the Republic's Military Attaché. There followed a purge of KAF officers with links to the royal family. Several highly experienced pilots were removed from their commands and posted abroad as Military Attachés, including Col Pal Sam Or of the *Groupe d'Intervention* (GI — Intervention Group), who was posted to Seoul in South Korea, Lt-Col Suoi Samphan (Taipei in Taiwan) and Lt-Col Sisowath Monipong (Paris). Colonel Norodom Vatvani, however, continued to play a key role in the KAF, overseeing a new training programme in Thailand, where Cambodian cadets were taken on charge by the Royal Thai Air Force.

FIGHTER PILOT TO INSTRUCTOR

Su Sampong was among those suspended from flying operations and was interrogated at length by military security officers. It was decided to post him away from fighter operations and to the Air Academy to serve as an instructor. He takes up the story:

"The Academy at Battambang was equipped with Gardan GY-80s and Cessna T-41Ds, the latter being the military version of the popular Cessna 172 reinforced for aerobatics. After a conversion

SO SETHI COLLECTION

OPPOSITE PAGE, TOP ***North American T-28D-15 serial 51-7555 of the Khmer Air Force* Groupe d'Intervention's *fighter squadron, based at Battambang in 1973, loaded with a standard configuration of four Mk 82 500lb bombs. Artwork TOM COOPER © 2021***

OPPOSITE PAGE, LOWER ***The KAF's pilot's wings incorporated the Hansa, the mythical bird on which Brahma goes to war in Hindu mythology.*** VIA AUTHOR

LEFT ***In 1973 Su Sampong became a flying instructor at the Air Academy, teaching on the Cessna T-41D. Here are three students of the 10th Class and a Taiwanese instructor (second left).***

course on the T-41D, I was sent to teach the cadets of the 10th Class, of which 67 ultimately graduated. We offered only primary training, with basic and advanced courses being undertaken as on-the-job training with operational units. Some cadets were also sent to Thailand for further courses on [Cessna] O-1s, T-28Ds or helicopters. Later, we received a batch of 12 T-28B/Cs from US Navy stocks that allowed advanced training at the Academy. There was also a small group of Taiwanese [Republic of China] Air Force instructors. However, they kept a low profile and wore Cambodian uniforms.

"I admit that I was a poor instructor. I have no disposition for it and incessantly requested my return to an operational unit. After several months, and owing to my previous experience with the USAF's *Rustic* forward air control [FAC] unit *[see part two in* TAH34 *— Ed.]*, I was posted as the new acting CO of the *Groupe Aérien d'Observation et d'Accompagnement au Combat* [GAOAC — Air Observation Group], becoming the youngest Group Commander. I was thus sent to Tây Ninh in south-eastern Vietnam for a conversion course on to the O-1 with the Republic of Vietnam Air Force (RVNAF — South Vietnamese), which mainly used the E and F models. The latter had reinforced brakes, and you had to use them sparingly. One South Vietnamese pilot on the same course with me turned his aircraft over when braking too hard on landing. The Americans gave us additional [O-1] Bird Dogs but many airframes were in poor condition. Many were D models with a variable-pitch propeller, which our mechanics spent much time on to cure regulator oil leaks. We preferred the E model with its fixed-pitch propeller. We also had some F models, well equipped with TACAN and VOR navigation aids and a codifying radio system that did not work.

"I remember ferrying two O-1s from Vũng Tàu in South Vietnam to Phnom Penh. I led with a non-functional radio. I asked my wingman to follow me closely. We made the transit at 10,000ft [3,000m] to avoid SAM-7 surface-to-air missiles. Just a few days earlier, in the Svay Rieng area, one had brought down a [Bell] UH-1H flown by the commander of the Helicopter Group, Col Long Trasom, killing all aboard.

"When I took over the GAOAC, the unit was disorganised and lacked experienced pilots. Morale was at its lowest ebb, as one of its pilots had been shot down by the anti-aircraft [AA] battery protecting the Presidential Palace. Since the bombing of the latter, any aircraft flying too close were fired on by the nervous gunners,

A pair of bomb-armed T-28Ds taxy out at a primitive makeshift airstrip for a ground-strike sortie in support of Cambodian troops in the besieged Kampong Thom enclave. The nearest aircraft, serial 51-3583, went on to serve with the Philippine Air Force after leaving Cambodian service in 1975.

KEN CONBOY VIA AUTHOR

AUTHOR'S COLLECTION

ABOVE ***In mid-1973 Su Sampong was appointed CO of the*** **Groupe Aérien d'Observation et d'Accompagnement au Combat** ***(GAOAC), at that time still using several Cessna O-1As of the original batch delivered in 1956. These carried the new unit's insignia on their fins but retained their former Royalist national markings, as seen here.***

including several airliners in the landing circuit into Pochentong. Fortunately, none was hit. That did not dissuade another T-28D pilot, Lt Pech Lim Kuan, from bombing the palace again on November 19, 1973. After this next attempt on his life, Lon Nol ordered that each mission was to be led by a "loyal pilot", who was ordered to shoot down any wingman he suspected of devious behaviour. It was in this deleterious atmosphere that we flew our T-28Ds.

"One day, a flight leader turned hard on my tail for what I took to be a firing pass. I immediately broke hard towards his T-28D in a climb, forcing him ahead of me. There was an acrimonious verbal exchange when we landed back at the base. It took weeks before confidence was restored and Lon Nol relaxed his absurd operational rules.

"At the GAOAC I enforced strict discipline when I discovered that operations were being performed in a casual way and that several pilots flew without their parachutes, as if this was some kind of flying club. I introduced standardised working methods learned with the *Rustic* FACs, and detailed debriefings. I also enforced strict maintenance procedures. Many of our aircraft were parked outside, without proper cover, and corrosion began to be a problem. That particularly hit the few O-1As still in service. The daily serviceability rate steadily improved, from an average of 12 serviceable O-1s to 16. The trend continued with additional airframes supplied by the Americans. We ended the war with around 40 O-1s on the line, attached to various bases or forward primitive airstrips, although Pochentong remained the main base, as well as the technical maintenance centre.

"We became an indispensable tool in the aerial war effort. All tactical operations were now co-

BELOW ***Cessna O-1D serial 57-2903 was transferred from the Royal Lao Air Force to the KAF in February 1974 for KAF pilot training at Udorn in Thailand, before being sent to Pochentong that June, when it was officially transferred to the KAF inventory for active service. Artwork by TOM COOPER © 2021***

JAKE WEHRELL

ABOVE ***A total of 14 Helio AU-24A Stallion gunships was received by the KAF during 1973–74, including 72-1322, seen here on a sortie in May 1973, one of three that escaped to Thailand in 1975. Despite its remarkable STOL capabilities, the type was not popular with its KAF pilots; two were lost in accidents and three were shot down.***

ordinated by the Tactical Air Co-ordination Centre (TACC), in conjunction with plans devised by the Combined Operations Centre (COC), an inter-services department of the Joint General Staff. Operating in the FAC role really changed my perspective of air operations, compared to the fighter pilot I was. We shared the misery of our infantry when living alongside them while operating from forward locations and realised how important air support was for them.

"The Americans gave us a squadron of Helio AU-24A Stallion mini-gunships, fitted with a sideward-firing 20mm Vulcan cannon as well as hardpoints for rockets and 250lb [110kg] Mk 81 bombs. The Stallions flew mostly at night with our AC-47Ds, known by their radio callsign *Loup-Garou [Werewolf]*, but sometimes supplemented us on FAC missions. An AU-24A crashed owing to an unknown cause during a dive. It was said that the lowering of the flaps had locked the stabilator. This did not increase the confidence of the crews. The type remained in service until the end of the war, but we would all have preferred additional T-28Ds."

NO MORE AMERICAN HELP

On August 15, 1973, Congress in the USA stopped funding American military operations in Cambodia, resulting in the cessation of all American air strikes in support of the Cambodian Army. The KAF now stood alone to continue the air war. The Khmer Rouges launched an offensive against Phnom Penh, stopped short by continuous attacks undertaken by the KAF. The Communists redirected their efforts to besiege several towns that could only be resupplied by air.

It was soon established that the KAF transport assets were insufficient for the task, and the Americans initially envisaged engaging Air America to supplement Cambodian assets. But by this stage of the conflict it was general knowledge that this "airline" was the operational air arm of the USA's Central Intelligence Agency (CIA). Consequently, the American embassy in Phnom Penh decided to finance local efforts, resulting in the creation of half a dozen airlines using a total of more than 60 aircraft, mostly Douglas DC-3s, DC-4s and Curtiss C-46s, flown by contracted American, Australian and Taiwanese pilots, who took many risks bringing in rice, fuel, troops and ammunitions and flying out refugees and casualties. Su Sampong's sister was also involved, co-establishing a small air taxi company named Indhanu Airlines, with a Beech C-45 and a Lockheed Lodestar. Indhanu's Australian pilots operated in and out of remote towns and settlements, landing on makeshift fields or sections of road, often under enemy shelling. Under the direction of Gen Harry C. "Heinie" Aderholt, the Americans established a support programme for Cambodia from Thailand in October 1973, and by mid-1974 the KAF had expanded into a force of more than 250 aircraft.

Aderholt helped to reorganise the technical support programme of the KAF, notably by overhauling its aircraft in Bangkok using the Thai-Am company. Advanced training was also provided by USAF instructors in Thailand. Su Sampong's cousin, Su Cchom Doeurn, was trained as an instructor and also served as a KAF test pilot, in charge of checking and evaluating repaired airframes. An advanced training stage

BENNET CRAWFORD VIA AUTHOR

ABOVE ***Lockheed 18 Lodestar N5135 (c/n 18-2496) was leased from Ken Benesh by air taxi company Indhanu Airlines, co-founded by Su Sampong's sister, Sokhomaly Suon Kaset, in the wake of the cessation of American military operations in Cambodia in August 1973. The aircraft later escaped to Singapore, where it was scrapped.***

in the USA was also organised for selected KAF officers, including Su Sampong, who was sent to attend the USAF's Squadron Officer School (SOS) from November 1973 to June 1974. He recalled:

"The stage began at the Language School in Lackland, Texas, for a thorough improvement of our English. The course emphasised organisation, planning and command procedures. We lived at the base with other foreign officers, the majority of which came from South Vietnam and Iran. Some Saudi officers lived more comfortably in rented houses downtown. The notion of leadership was particularly emphasised through collaborative working sessions, rather than the strict military discipline I was used to. The exposure to other military cultures was very enriching."

RETURN TO CAMBODIA

Having graduated from the SOS, Su Sampong returned to Cambodia, where the situation had deteriorated. The Khmer Rouges now controlled more than half of the country. Routes into Phnom Penh had been cut and most supplies were being brought in by boats via the Mekong, along the banks of which the Communists were amassing troops and sowing floating mines. Each ship convoy was now an important joint Cambodian-South Vietnamese operation. It was in this context that Congress in the USA drastically further reduced aid to Cambodia. A proposal to deliver 24 Cessna A-37B ground-attack jet aircraft to the KAF was abandoned at the very moment when the service was at its peak in terms of efficiency, flying up to 150 tactical sorties a day.

The American Military Attaché indicated that the KAF was now fast approaching the technical level of the Royal Thai Air Force and RVNAF. The American Ambassador to the Khmer Republic, John Gunther Dean, stated in his January 1975 monthly report that the "KAF is the best program [sic] we have here". This reduction in American aid ultimately led to the demise of the Khmer Republic. Su Sampong, however, became increasingly disillusioned with the incompetence and corruption of the administration:

"Hyperinflation hit our daily life hard, and one had to wonder how to take care of the family with our shrinking salaries. I tried to be as honest and

BELOW ***By 1974 most of the Cambodian towns besieged by the Khmer Rouges were surviving almost entirely owing to the air bridges put in place by the KAF and local charter airlines. Here Curtiss C-46 N9760Z of the Phnom Penh-registered Tri-9 Corporation taxies out for another sortie from an improvised airstrip at Kampong Cham.***

BENNET CRAWFORD VIA AUTHOR

SU SAMPONG COLLECTION VIA AUTHOR

ABOVE ***Following his seven-month stint at the USAF's Squadron Officer School in the USA, Su Sampong returned to Cambodia in the summer of 1974, when he was appointed Operations Officer of the*** **Groupe de Transport.** ***He is seen here second from right, with fellow crewmembers of a Fairchild C-123K, which has been named*** **Kung Fu.**

honourable as possible and was convinced that we had to fight the Communists with our utmost determination. But seeing the wives of fallen comrades without any resources other than to sell goods in the streets, while high-ranking officials pocketed their widows' pensions, incensed me. For whom were we being forced to risk our lives?"

Promoted to the rank of Major, Su Sampong assumed that he would be sent back to the GAOAC, but he was instead appointed Operations Officer of the *Groupe de Transport* (GT — Transport Group). At that time the unit comprised a squadron each of C-47s and Fairchild C-123Ks, and had absorbed the *Groupe de Liaison* (GL — Liaison Group) and its miscellaneous fleet of DC-4s and de Havilland Canada L-20 Beavers and U-1 Otters.

Having always previously flown single-engined types, Su Sampong was sent to the RTAF base at Udon in north-eastern Thailand for conversion on to the C-123K. He recalled:

"My American instructors introduced me to multi-engined aircraft. Usually our transport pilots were given initial training on the C-47 at the Air Academy at Battambang, but owing to the rushed situation I was sent directly to convert on to the Provider, which had a mixed-power system, with two Pratt & Whitney R-2800 piston engines and two General Electric J85 turbojets. Both used the same type of fuel. The jet engines were particularly useful in providing additional thrust when taking off fully loaded. We also used the jets during parts of the flight, for example when climbing at full power after a low-level parachute drop. The conversion course ended with a series of take-offs and landings on short improvised runways, a procedure that we put to good use after our return to Cambodia. The final qualification flight ended with a return to the apron, where we were welcomed with coloured smoke grenades and a parachute deployed and attached to the open rear ramp.

"Back at Pochentong I devised an improvement programme for our pilots, many of whom had just graduated and were not trained for night flying. We had initially received eight C-123Ks, all former RVNAF examples. The Americans handed over four more, fresh from the USAF's Operation *Ranch Hand* defoliation project, in which the cockpit lighting system and instrument panel were slightly different from the standard version. Later, we received more, with some 17 C-123Ks in the inventory by January 1975, including a former NC-123K gunship, which kept its specific camouflage scheme.

"Most of our tasks were resupply missions to our besieged outposts or cities. We used stretches of road as runways or even streets among charred buildings in some cities. Otherwise we dropped the supplies by parachutes. We also provided logistical support for the other air bases at Kampong Chhnang, Battambang, Kampong Cham, Ream and Kampong Som. Our main depot was Pochentong, where American-contracted C-130s and DC-8s delivered fuel, ammunitions and rice from Bangkok and Saigon. An air bridge to Phnom Penh was established following the closure of the Mekong River to boat traffic.

"We now encountered fierce enemy anti-aircraft fire; SAM-7 missiles brought down one of our Providers near Oudong, as well as one of our two Airborne Command Post C-47s. In early 1975 a new enemy offensive brought Khmer Rouge forces to the gates of the capital, where the airport was

BENNET CRAWFORD VIA AUTHOR

ABOVE ***Previously converted for the aerial defoliation role, UC-123K serial 54-578 joined the KAF in August 1973. It is seen here having sunk a mainwheel into an unseen hole while using a stretch of road to offload supplies to an Army garrison, highlighting the conditions in which the Cambodian transport crews were forced to operate.***

hit by 107mm rockets, then 105mm and 130mm guns. Our counter-batteries tried to silence them. Patrols of T-28Ds and UH-1H gunships patrolled the airbase perimeter, providing top cover for departures and arrivals of transport aircraft. We tried to protect our aircraft in dispersed protected pens. The base was soon full of trenches and bunkers. When a shell exploded, we all rushed to the nearest shelter. Our T-28Ds went into action, attacking the suspected location of the gun that had just fired. Then normal operations resumed. At nightfall we dispersed our aircraft to the other bases. Each night, two AC-47Ds took turns to cover the Phnom Penh area."

A DETERIORATING SITUATION

On April 1, 1975, Marshal Lon Nol resigned as President and sought asylum in Indonesia. The same day, the last governmental enclave on the Mekong, Neak Luong, fell to the Khmer Rouges after a siege of several months. A new transitional government took over under Saukham Khoy, who opened negotiations with Prince Sihanouk. The situation continued to worsen, however. The intensity of the shelling at Pochentong was such that the T-28Ds were forced to operate from a nearby stretch of road. Pursuing a "scorched-earth" policy, the Khmer Rouges torched dozens of villages around the capital, pushing thousands of starving refugees into Phnom Penh, increasing the government's problems. The centre of the city was now randomly shelled. Su Sampong recalled:

"We pitted all our forces against the enemy. We were ordered to use our Providers to bomb them. The standard warload was 16 Mk 82 500lb bombs, chained on pallets in the cargo compartment. After some trials we devised a tactic in which we attacked, usually at sunrise, at around 3,000ft–5,000ft [900m–1,500m]. On the last leg to the target, the navigator lay on the floor over an opened ventral hatch fitted with a rudimentary grid-based aiming device, initially providing headings for the pilot every 5min, which increased to one a minute 3min before the bombs were dropped. The pilot concentrated only on flying, taking visual reference points as per a parachute drop, while the copilot controlled the throttles and propeller-control levers. At the drop order, the loadmasters released the chain-links while the pilot pulled up, pushing the jet engines from 65 to 100 per cent power. The bombs departed and fell along a path around 200m [600ft] long and 100m [300ft] wide."

While Cambodian troops continued to encounter fierce resistance along the entire length of the front line, the new government procrastinated with endless discussions, relieving key officers and wreaking havoc on the military chain of command. Many units were left leaderless, failed to receive any more directives or were left to fend for themselves. On April 3, 1975, the Americans evacuated their Embassy and some key Cambodian personnel during Operation *Eagle Pull*, their helicopters being covered by US Navy F-4 Phantoms and A-7 Corsairs from the *USS Coral Sea*. American C-130s and DC-8s continued to bring in deliveries and evacuate foreigners until April 11, when the ferocity of enemy shelling forced the closure of the air bridge. On April 14 a disgruntled KAF T-28D pilot bombed the Prime Minister's residence, and two days later the Khmer Rouges cut the

AUTHOR'S COLLECTION

ABOVE ***All departures and arrivals of the transports involved in the Phnom Penh "air bridge" in 1975 had to be covered by KAF T-28s or gunship helicopters. Here a T-28D of the*** **Groupe d'Intervention,** ***fitted with four napalm tanks, takes off to provide an Airlift International DC-8-63 with top cover before the latter departs Pochentong.***

road linking Pochentong Airport to Phnom Penh. Nevertheless, the KAF continued to undertake missions. Su Sampong recalled:

"The Khmer Rouges were now so close to the airbase that they could shell us with mortars, destroying several aircraft and killing some of our pilots and members of their families living on the base. On April 16 I drove my jeep down to Phnom Penh to look after my wife and son, just before the route was cut. The roadside was full of refugees heading downtown, where the enemy was now raining down rockets and artillery shells. After gathering a few things, I drove my wife to her parents' house and asked her to stay put there. The city was full of rumours, notably that an agreement had been reached with Prince Sihanouk for a ceasefire and his return. This created even more confusion, and many units abandoned their defensive positions. I was then warned that all KAF officers stranded in the city would be instructed to rendezvous at the Olympic Stadium, which had been turned into a helicopter landing area, at which point orders would follow.

"Once there I found a lot of people, many attending funerals of their relatives. My cousin Doeurn was there, still convalescing after having been shot down recently. By 0200hr a group of Hueys had picked us up and flown us to Pochentong, as in my case, or Kampong Chhnang. Back at base I found that three C-123Ks had been destroyed. At dawn, I was ordered to go to Kampong Som to deliver a load of 500lb bombs for our T-28Ds. While taxying out, enemy shells began exploding all around. After completing the round-trip, I was sent back to Kampong Som again to bring back a fuel cistern, which occupied the whole length of the C-123K's fuselage. During the flight back, one of the loadmasters warned us that the cistern was slowly leaking. With some anguish I pressed on to Phnom Penh among the fuel fumes, before being directed to Kampong Chhnang to bring back a KAF security squad to reinforce the airbase defences.

"As we landed back at Pochentong the enemy bracketed their guns on us. The troops evacuated the aircraft in haste among exploding shells. I decided to take off again immediately. Just after we had departed the parking area, a rocket impacted the very spot we had been on. I accelerated on the runway amid a series of exploding shells. To safeguard my aircraft, I decided to land at Kampong Chhnang, where I found a confused situation. A group of UH-1Hs from Phnom Penh had just landed carrying members of the government, in order to refuel. An angry mob confronted the officials, treating them as cowards who were trying to flee the country. The officials insisted they were heading to a remote area in the north of the country to establish a last-ditch redoubt. None of us were convinced and the tension reached a high point. Finally, fending off the crowd of angry KAF officers was the CO of the airbase at Battambang, Col Neang Lee, who had commanded Kampong Chhnang and knew most of the men there well. He persuaded the mob to let the officials go. The helicopters took off and set course, as we expected, for Thailand. At noon we heard on the radio that the government had capitulated. Columns of Khmer Rouges were entering Phnom Penh without resistance. We were stunned and desperate.

"Our senior officers gathered us to discuss

BENNET CRAWFORD VIA AUTHOR

ABOVE ***The KAF C-123Ks were supplemented in the Phnom Penh air bridge operations by contracted civilian transports, including a sole Aviation Traders Carvair, N33AC, named*** **Barb*****, operated by Air Cambodge, Cambodia's national flag-carrier. It is seen here taxying in at Pochentong after another resupply run to a besieged town or city.***

what would happen next. Some wanted to stay and fight until the end, others wanted to escape to Thailand. There was a lot of emotion, and some people were crying. Finally, it was decided to evacuate the maximum possible number of aircraft to Thailand. As the aircraft started leaving, panic began to grip some of our mechanics, who feared that there would not be room for their families, and they began to place obstacles on the runway before order was restored and an organised departure schedule imposed.

"All my thoughts then were for my family and how to extricate them from Phnom Penh. By the evening, I was still there wondering what to do. I approached a young Huey pilot who told me that his family was also trapped in Phnom Penh. I suggested that we go there in his helicopter to pick up our relatives, but he explained that, being newly graduated, he had not been trained to fly at night. I told him I could help him by navigating, but he refused. I lost my temper and had to be calmed down by the other pilots, who persuaded me to depart as soon as possible for Thailand. It would be better to be alive there to find a way to help my family than stay here for a certain death.

"Finally, at 0100hr, I decided to depart in my C-123K. As soon as I lowered the rear ramp, a mass of people rushed in and my loadmasters closed the doors with great difficulty. As I was lining up on the runway, a soldier driving a scooter stopped in front of me, hoping that I would stop and pick him up. No hesitation. I accelerated at the risk of colliding with him. Our take-off was sluggish, flaring for some distance before beginning a steady climb. Then suddenly, came a cry from the hold — fire! After checking, no fire was detected; some passengers had noticed the blue flames of the exhaust and mistaken it as the beginning of a fire.

"As I had no navigation charts for Thailand, I took an approximate heading for U-Tapao airbase [90 miles (140km) from Bangkok; the Americans had indicated to Cambodian senior officers that U-Tapao would serve as the main reception point for all aircraft fleeing Cambodia should the regime collapse. The same information had also been given to the South Vietnamese]. Thankfully, it appeared that the CO of Kampong Chhnang, Col Phlok Saphat, who was aboard, had a bag of maps of Thailand. I then asked Col Long Sithiya, an excellent transport instructor pilot, to replace my young copilot, who was not yet qualified for night flying. With his help, I acquired the TACAN of U-Tapao and made a direct-approach landing.

"After parking at U-Tapao I counted no fewer than 87 passengers aboard my aircraft, in addition to the crew. I was surprised and overjoyed to find my cousin Doeurn among the passengers. His original plan had been to take the back seat of the T-28D of the GI's CO, Col Tam Sam Hong. At the last moment, however, Doeurn could not find a helmet and, as he was still in plaster and could not move easily, he was told to embark in my Provider. It saved his life; Col Hong's T-28D crashed soon after take-off."

ESCAPE TO AMERICA

Some 97 KAF aircraft escaped to Thailand, although 100 others were captured intact by the Khmer Rouges. Su Sampong continues:

AUTHOR'S COLLECTION

ABOVE ***One of the ten KAF C-123Ks that escaped to Thailand after the fall of Phnom Penh on the apron at Don Muang Airport in Bangkok. For readers interested in finding out more about Cambodian military aviation and the Khmer Air Force, visit the fascinating website established by the late Brig-Gen So Satto at www.khmerairforce.com.***

"We regrouped on a field adjacent to the huge U-Tapao airbase, home to numerous B-52 bombers. We lived under tents not far from the beach. Soon afterwards, we witnessed the influx of RVNAF aircraft signalling the fall of South Vietnam. The Americans evacuated most of them to the carrier *USS Midway*. One of the A-37Bs slung beneath a CH-53 helicopter broke free and crashed into the bay. We were all desperate and concerned about our families. A group of pilots requested repatriation after hearing a Khmer Rouge reconciliation offer on the radio. We tried to dissuade them. The Thais drove them over the border. They were immediately executed.

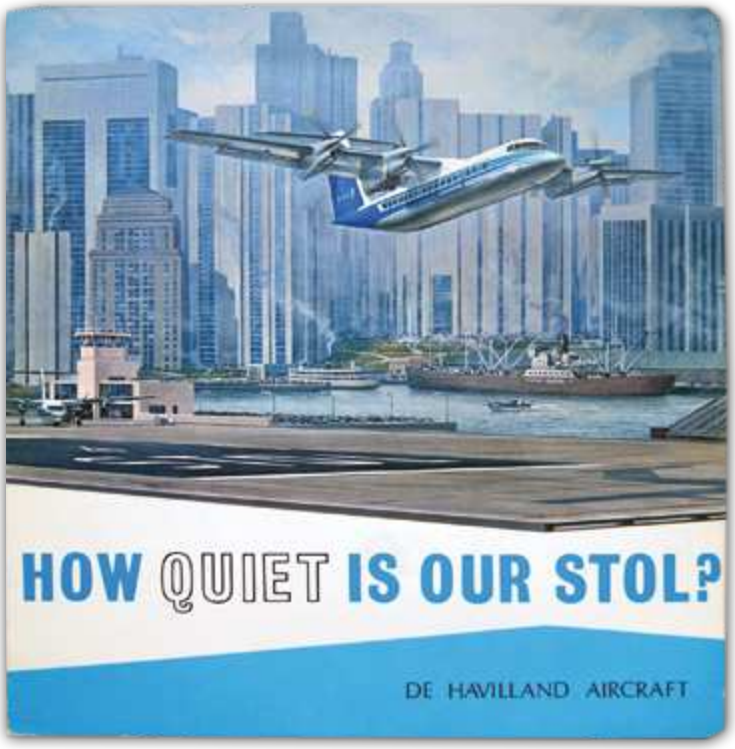
"We were transferred to Guam, where we boarded a USAF Lockheed C-141 for California, where we were accommodated at an improvised refugee camp on a US Marine Corps Base. We were offered political asylum, but I preferred to apply for asylum in France, where I felt more comfortable culturally, and to where I moved ultimately. Very little news filtered out of Cambodia after the Khmer Rouges took over, but we did get reports that terrible events were taking place there, most of which the media disregarded.

"I had a very bad feeling about it, knowing only too well the radical social reorganisation these fanatics had implemented in the areas they had occupied before our final defeat. One day my sister, who worked as a journalist for an American journal, asked me to go to a refugee centre in the northern suburbs of Paris to interview a Khmer Rouge defector. He told us that all the people living in the quarter of Phnom Penh reserved for KAF personnel and the quarter in which my father-in-law lived had been executed. I never heard from my wife, son and other members of my family, again. Hope, however, is still deep inside me sometimes.

"I now had to rebuild a new life. One day some people came to see me, presenting themselves as French intelligence officers. They were seeking former Cambodian and South Vietnamese pilots with Skyraider experience to serve with the aerial squadron of the Gabonese Presidential Guard. *[See Arnaud Delalande's* All The President's Men *in* TAH22 *— Ed.]* I declined, stating that my oath as a Cambodian officer meant that I could serve only my country and its people, and that I had no desire to be a mercenary. Apart from flying with friends at a flying club, I had no further opportunities to engage my passion for flying."

Su Sampong settled in Paris with what was left of his family, including his cousin Su Chhom Doeurn and sister Sokhomaly Suon Kaset, working in various positions within the hospitality industry. He became a founding member of the Khmer Air Force Veterans Association, established by former Brig-Gen So Satto. Before he died aged 79 in Paris on May 17, 2020, Su Sampong gave a long interview, recorded by the Historical Department of the Armée de l'Air at Fort de Vincennes, from which the recollections in this three-part series have been taken.

ACKNOWLEDGMENTS *The author would like to thank Su Sampong, So Satto, Su Chhom Doeurn, So Sethi, Darasy Var, Gérard Gacoing, André Bellouard, Gérard Cavenel and Ken Conboy for their invaluable assistance with the preparation of this three-part* TAH *series*



The Impossibly Glamorous World of Perceived Noise Decibels . . .

Digging deep into the *TAH* archives **NICK STROUD** rediscovers a long-lost gem of audio pleasure, acquired as a child and played to death while other children were enjoying *Chirpy Chirpy Cheep Cheep*

AS A FIVE-year-old child, my favourite 45 r.p.m. 7in singles were, in order, *Tom Hark* by Elias and his Zig-Zag Jive Flutes, *Goldyloppers and the Three Bearloaders* by much-cherished nursery-rhyme-mangler Stanley Unwin, and, last but definitely not least, a promotional 33⅓ r.p.m flexidisc (you will remember these if you grew up in the late 1970s) acquired by my aviation journalist father, entitled *How Quiet Is Our STOL?* This obscure little gem was issued by de Havilland Canada to extol the virtues of the company's prospective new feederliner, the four-turboprop-engined DHC-7, or Dash 7, which made its maiden flight on March 27, 1975.

Top of the props

I listened to this flexidisc hundreds, if not thousands, of times during my childhood, the urbane Canadian narrator sounding to me like the epitome of transatlantic sophistication. His voice was the very essence of an impossibly glamorous world, in which advertising execs boarded tastefully appointed turboprops at downtown airports, behind which loomed a backdrop of shimmering skyscrapers, where 30min previously the immaculately suited executives had been standing at carpet-to-ceiling windows on the 130th floor sipping Martinis as a prelude to escaping the city's steel canyons by means of a runway built into the harbour below.

Pretty heady stuff, considering the flexidisc was essentially 5min 1sec of comparative recordings of different aircraft flying overhead, with the aforementioned narrator, whom I was sure was wearing a perfectly laundered tab-collar shirt with a slim wool-knit tie under a finely-tailored seersucker suit with thin lapels and five-inch side vents, explaining why the Dash 7 was the perfect aircraft with which to "establish a new metropolitan STOL transportation system" — which sounded ineffably cool to me. I had no idea what a metropolitan STOL

ABOVE ***The author's prized 33⅓ r.pm. flexidisc,*** **How Quiet Is Our STOL?*, *issued by the publicity department of de Havilland Canada circa 1975. If you want to enjoy this classic of comparative aircraft noise levels for yourself, a Sound Cloud file is accessible on Hush-Kit page*** **The Whispering Blades of The Flying Mad Men** ***(www.hushkit.net).***

transportation system was, but I wanted one.

The liner notes of the flexidisc's gatefold sleeve explain that the DHC-7 has been specially developed to "permit its unobtrusive operation into built-up areas — the maximum noise level produced will not exceed 95 PNdB [Perceived Noise Decibels] at a distance of 500ft [150m] from the aircraft". It goes on: "This recording has been prepared to provide a truly subjective appreciation of what a 95 PNdB noise level means in comparison with both conventional transport aircraft and downtown noise as represented by an eight-lane freeway".

An EIGHT-LANE FREEWAY? What in the name of Christmas daisies was that? It sounded like a much, much cooler version of our motorway, probably where cars with fins were driven by men in fedoras. I'm not quite sure why I had this 1950s notion about all of this, as the record probably dates from around 1974–75, when all that terrific *Mad Men*-era stuff had long since devolved into long hair and flares — but listening to it again now, I still see Ford Edsels and vast station-wagons with wood panelling moving along a coastal highway like ants.

The sound of silence (almost)

Anyhow, after a brief intro from the narrator (who I imagined was probably the aircraft's designer or at least the chief test pilot, which I now admit is unlikely), the listener is treated to the sound of a Boeing 727-100 passing overhead at a whopping peak noise level of 117 PNdB (hopeless!), before the far more satisfactory General Electric T64 turboprop-powered DHC-5 Buffalo (109 PNdB) makes its pass. Following hot on its heels is another jet, a DC-9-10, which is between the big tri-jet and the sturdy Buffalo at 114 PNdB. Next up is our hero, the Dash 7, which tiptoes by discreetly at a 95 PNdB whisper — hurrah for de Havilland! This was possible because the Dash 7's engine configuration was specially designed to have a very low propeller tip speed, aided by low-noise paddle-type prop-blades. Buried air intakes and overwing exhausts for the type's Pratt & Whitney Canada PT6A-50 turboprops also added to the Dash 7's enviably low noise signature.

To show just how quiet the new feederliner was in an urban environment, the record then provides the sound of a busy eight-lane freeway — imagine my excitement! — at 90 PNdB, with a repeat of the Dash 7 following immediately afterwards. "This aircraft will provide attractive transportation for 48 passengers between conveniently located downtown Stolports", explains the narrator, before assuring the listener that the new aircraft is built on firmly established de Havilland principles. Stolports — wow! Can we make one in the garden?

As the hushed tones of the Dash 7 flying overhead disappear into the flexidisc's run-off, my imagined 1950s-vintage *Sim City* world wobbles and fades to black — shall we play it again?

This is an edited version of an article originally published in May 2012 by online blog Hush-Kit, the alternative aviation magazine, highly recommended by TAH. *For a unique sideways look at aviation visit* ***www.hushkit.net***

DIEPPE

The Luftwaffe Perspective

Jagdgeschwader 2 operations: August 19, 1942

In August 1942 the Allies launched an amphibious attack on the French town of Dieppe in an attempt to probe the German defences of "Fortress Europe". The operation was a disaster, with Luftwaffe fighter unit JG 2 doggedly holding the line. **Dr ANDREW ARTHY** chronicles a brutal day of fighting for the Richthofen Geschwader

MORTEN JESSEN VIA AUTHOR

Focke-Wulf Fw 190A-2s of 7./JG 2 taxy out for a sortie at Théville on the Cotentin Peninsula in the summer of 1942. "White 8", WNr 0120333, was the mount of **Leutnant** ***Jakob Augustin, and, like the others here, carries the 7. Staffel's distinctive emblem depicting a top hat (representing the British) under the thumb of Germany, designed by unit members*** **Oberfeldwebel** ***Klee and Ltn Schmidt.***

MAP BY MAGGIE NELSON

BY THE END of the Second World War, Luftwaffe fighter unit *Jagdgeschwader 2* (JG 2) "Richthofen" had earned a distinguished combat record, but the pinnacle of its wartime operational success came on August 19, 1942, while opposing the disastrous Allied amphibious landing at Dieppe, Operation *Jubilee*. The Dieppe raid saw a significant attempt by the Western Allies to bring the Luftwaffe on the Channel Front to battle, and JG 2 was right in the midst of the constant aerial duels that day. It was a strenuous and draining day for the airmen of both sides, with many taking part in four or five sorties. By the time the sun had set, the Richthofen Geschwader had claimed an astonishing 60 aerial victories, but had also suffered significant casualties of its own.

Battle-hardened veterans

Formed in May 1939, JG 2 enjoyed great success flying the Messerschmitt Bf 109 during the Battle of Britain the following year; and, in company with JG 26, helped establish a degree of Luftwaffe dominance on the Channel Front in the summer of 1941. A core of highly experienced flying personnel was created in those years, and many of the Richthofen pilots active in the skies over Dieppe in August 1942 were veterans of the air fighting with the RAF.

A significant change in equipment occurred in 1942, as almost the entire *Geschwader* took the radial-engined Focke-Wulf Fw 190A-2 and A-3 on strength.[1] The new type gave the pilots of JG 2 a slight edge over the British pilots flying the Spitfire V, by far the most common fighter in the RAF inventory during the Dieppe raid.

The German fighter unit located closest to the Dieppe landings, JG 2 was subordinated to the *Jagdfliegerführer 3*, *Oberst* Max-Josef Ibel, who was himself operating under *Luftflotte 3*. It was composed of three *Gruppen* — I./JG 2; II./JG 2 and III./JG 2 — each with three *Staffeln*, and there were also two semi-independent Staffeln, 10.(Jabo)/JG 2 with Fw 190 fighter-bombers, and 11.(Höhe)/JG 2 with pressurised Bf 109G-1 fighters for high-altitude operations. All of these elements were based within 200km (125 miles) of the Allied beachhead, with the exception of the 8. Staffel, meaning the Geschwader was perfectly located to provide a timely and effective response.

The *Kommodore*, *Major* Walter Oesau, was also the most successful pilot in the Geschwader, with 101 victories to his credit, but each Gruppe had at least one high-scoring ace. In I./JG 2 there was Josef Wurmheller (54 victories); II./JG 2 had Erich Rudorffer (44), while III./JG 2 had Egon Mayer (50) and Siegfried Schnell (65).

The only other German fighter unit based on the Channel Front was JG 26, which would contribute almost as many sorties as JG 2 on August 19, but claim fewer victories and suffer fewer casualties. The Germans had long anticipated an Allied cross-Channel landing, and the Luftwaffe was intended to be a major deterrent to such an undertaking. So it would prove.

Debate has raged since the end of the war about

Jagdgeschwader 2 — August 19, 1942

Unit	Base	Distance to Dieppe	Commander
Stab JG 2	Beaumont-le-Roger	100km (62 miles)	*Major* Walter Oesau (101 victories)
Stab I./JG 2	Tricqueville	80km (50 miles)	*Hauptmann* Erich Leie (42 victories)
1./JG 2	Tricqueville		*Oberleutnant* Hans-Jürgen Hepe (8 victories)
2./JG 2	Bernay	100km (62 miles)	*Oberleutnant* Siegfried Bethke (12 victories)
3./JG 2	Tricqueville		*Oberleutnant* Elmar Resch (5 victories)
Stab II./JG 2	Beaumont-le-Roger	100km (62 miles)	*Hauptmann* Helmut-Felix Bolz (9 victories)
4./JG 2	Beaumont-le-Roger		*Leutnant* Kurt Bühligen (24 victories)
5./JG 2	Beaumont-le-Roger		*Leutnant* Wolf von Bülow (5 victories)
6./JG 2	Beaumont-le-Roger		*Oberleutnant* Erich Rudorffer (44 victories)
Stab III./JG 2	Théville	190km (118 miles)	*Hauptmann* Hans Hahn (64 victories)
7./JG 2	Théville		*Oberleutnant* Egon Mayer (50 victories)
8./JG 2	Brest-Guipavas	440km (273 miles)	*Oberleutnant* Bruno Stolle (19 victories)
9./JG 2	Théville		*Oberleutnant* Siegfried Schnell (65 victories)
10.(Jabo)/JG 2	St André-de-l'Eure	115km (71 miles)	*Oberleutnant* Fritz Schröter (2 victories)
11.(Höhe)/JG 2	Monchy-Breton	110km (68 miles)	*Oberleutnant* Julius Meimberg (21 victories)

why the Dieppe landing was attempted; but it was undoubtedly a significant amphibious operation, involving more than 250 ships and landing craft, eight destroyers, 6,086 troops and 29 tanks. The 2nd Canadian Infantry Division made up the majority of the landing force, and the first troops stormed ashore around 0520hr, meeting German Army defenders who had been alerted 30min earlier. Providing cover in the skies above were 56 RAF and three USAAF fighter squadrons, plus 12 Allied bomber and reconnaissance squadrons. Spitfires, Hurricanes, Mustangs, Blenheims, Beaufighters, Defiants, Bostons and Typhoons all played a role, maintaining a constant air umbrella over the beachhead and carrying out ground-attack and miscellaneous duties. This meant there would be plenty of targets for the pilots of JG 2.

The opening stages

During the summer of 1942 JG 2 pilots had been flying to inland dispersal airfields at dusk on most days; consequently, the unit's aircraft were not at their main operational bases at daylight on August 19. As news of the Dieppe landings filtered through, there was a mad scramble to wake the men, get aircraft ready and fly them off as quickly as possible to their primary airfields. As a result, many of the earlier JG 2 missions were only flown in *Rotte* (two aircraft), *Schwarme* (five) and *Staffel* (usually nine or more aircraft) strength. These small missions would be heavily outnumbered by the Allied standing patrols.

Oberleutnant (Oblt) Fritz Schröter's semi-autonomous *Jabostaffel* had only 15 Fw 190 fighter-bombers and a similar number of pilots on strength, but it was perhaps the most successful element of the entire Geschwader on August 19. Some pilots of the Staffel were asleep at their quarters at the Château de Louvigny, a short drive from their forward airfield at Caen-Carpiquet, and others were at Morlaix after flying a mission to England the previous evening. Both places received frantic phone calls at dawn — "This is no joke, the English have landed at Dieppe!" —

Luftwaffe groundcrew move Fw 190A-2 "Black 1" of 5./JG 2 the old-fashioned way. The unit was based at Beaumont-le-Roger, along with the rest of the Geschwader's II. Gruppe, in August 1942; it was tasked with defence of the Channel Front, having recently swapped its Messerschmitt Bf 109s for the far more capable "butcher bird", as the Fw 190 came to be known.

MORTEN JESSEN VIA AUTHOR

VIA AUTHOR x 3

ABOVE LEFT ***Oblt Fritz Schröter,*** **Kommandeur** ***of fighter-bomber unit 10.(Jabo)/JG 2.*** **ABOVE CENTRE** ***Günther Seeger of 3./JG 2, who shot down a pair of Spitfires in the morning of August 19, shortly before being shot down and baling out himself.*** **ABOVE RIGHT** ***Ltn Kurt Bühligen, who led 4./JG 2 of the II. Gruppe during the Dieppe raid.***

and three pilots at Caen were assigned to fly an initial armed reconnaissance of the landing zone. *Leutnant* (Ltn) Leopold Wenger's heavily-laden Fw 190 failed to get airborne, as the Austrian pilot recalled in a letter home:

"Since I figured there would be ships worth attacking, I loaded my 'plane with an especially heavy bomb [500kg SC 500]. But I was very unlucky as well as lucky at the same time. In rolling along to take-off, the undercarriage collapsed, and I slid across the grass on my bomb. It was not a very pleasant experience, when you think of the explosive effect of the bomb or when you have been able to watch its effect during an attack. So I missed the first mission."

The two other Fw 190s continued to Dieppe and attacked a warship. However, *Feldwebel* (Fw) Karl Blase's aircraft was hit by groundfire, and an anti-aircraft shell badly damaged the propeller and engine of *Unteroffizier* (Uffz) Werner Magarin's Fw 190A-2. Magarin was able to make a forced landing at Paluel, to the west of Dieppe, and after making a visit to the nearby battlefield, he returned to his unit the next day.

The men of II./JG 2 enjoyed the luxury of a château at Beaumont-le-Roger as their accommodation, and they were shaken from their slumber at dawn. The raid was a complete surprise to the *Staffelkapitän* (Staka) of 4./JG 2, Kurt Bühligen, who would go on to claim four victories over Dieppe. The Gruppe sent out at least two early small-scale reconnaissance missions to try and establish what was going on.

A nasty shock

As reports came in of an Allied landing, most I./JG 2 pilots were still at their overnight dispersal airfields, Rouen-Boos and Dreux. However, Uffz Kurt Epsiger and a comrade from 1./JG 2 were airborne on a routine morning coastal patrol, and must have received a shock when they came upon a sky full of Allied aircraft at 0645hr. Epsiger claimed the first JG 2 victory of the day, noted as a "Hampden", actually a Boston of No 418 Sqn RCAF. The damaged aircraft ditched in the Channel, and air

A pair of Fw 190s of 7./JG 2 at Théville in the summer of 1942. Designed purely as an air superiority fighter, the Fw 190A established an immediate ascendancy over the Spitfire V when the former was introduced in late 1941, forcing the speedy development of the Spitfire IX.

MORTEN JESSEN VIA AUTHOR

VIA AUTHOR

ABOVE ***Douglas Boston III AL775, one of the No 88 Sqn aircraft that participated in the air operations over Dieppe on August 19, 1942. The unit concentrated on destroying field-gun emplacements overlooking the beaches. Despite heavy fighter escorts accompanying the medium bombers on the day, several Bostons were lost to JG 2.***

gunner Sgt C.G. Scott heroically saved his fellow crewmen from drowning. He was subsequently awarded the Distinguished Flying Medal (DFM).[2]

Also over the beach early was the highly experienced *Kommandeur* of II./JG 2, *Hauptmann* (Hptm) Helmut-Felix Bolz, a veteran of the Spanish Civil War. He came across a pair of tactical-reconnaissance Mustangs, probably of No 26 Sqn, and downed them both.[3] There were several encounters during *Jubilee* between these recently introduced types, and the Luftwaffe pilots found that the Mustang turned tighter than the Fw 190 at low altitude, but that the latter had a superior rate of climb.

On hearing of the landings, 3./JG 2 quickly transferred to its main base at Tricqueville, and almost immediately took off again for the newly established beachhead, where Staka Elmar Resch spotted "three large ships and several small ones in motion. There were also a lot of Spitfires. I had no more doubts — an invasion was in progress".[4] His men subsequently engaged dozens of Allied aircraft, claiming the destruction of two Spitfires.

Next up, Kommandeur Erich Leie led his *Gruppenstab* to Dieppe between 0712hr and 0742hr, where he engaged an estimated 20 Spitfires over the town. However, because of the limited number of German aircraft involved, Leie reported that he was unable to break up the larger British formations. The German airmen had not been involved in such large-scale combats for some time, and the RAF pilots were tenacious in their defence of the beachhead.

Bühligen led 4./JG 2 to the battle area around 0800hr and, like other JG 2 pilots on the day, they were astonished by what they saw. In a long aerial combat with Spitfires, Bühligen's men claimed three successes, with Ltn Ludwig Spinner forced to bale out of his Fw 190A-3 near Rouen after it was hit in the cockpit, wounding the pilot.

The 11. Staffel of JG 2, with its rare high-altitude Bf 109G-1s, flew alongside elements of JG 26, its only victory claim for the day coming at 0835hr, to the south-west of Le Tréport.

Combat intensifies

Although Leie was badly outnumbered on his first mission of the morning, things were quite different when I./JG 2 next took to the air. The Kommandeur was able to assemble most of his Gruppe, and they arrived at Dieppe soon after 0900hr to be greeted by an umbrella of Spitfires. They also sighted and engaged a formation of Boston IIIs of No 88 Sqn RAF, which were busy bombing a German coastal gun battery from an altitude of 5,000ft (1,500m).

Among the German pilots taking part in the mission was 2./JG 2's *Oberfeldwebel* (Ofw) Josef Wurmheller, whose performance on August 19 became legendary. He flew throughout the day with one foot in a plaster cast as the result of a recent domestic accident. It was Wurmheller who claimed the first successes in this morning combat; a Spitfire and a "Blenheim" (actually one of the No 88 Sqn Bostons) shot down at 0908hr and 0912hr respectively, and another Spitfire soon after. Four more victories would be claimed by other members of the Gruppe, but Leie was lucky to make it home after a cannon shell struck his Fw 190. Wurmheller's aircraft was also hit by enemy fire, and he made a forced landing in a field near Dieppe, sustaining bruises and a slight concussion. Despite these new injuries, he was soon back at Tricqueville ready to take off again. Ofw Karl Schweikart did not have such luck, as several Spitfires targeted him and he crashed into the Channel. His Staka had the sad duty of sending a condolence letter to his family.

JECKEL VIA AUTHOR

ABOVE ***Pilots of JG 2 confer beside their Fw 190As in France. From left: Hptm Hans-Jürgen Hepe,*** **Staffelkapitän** ***of 1./JG 2; Ltn Horst Zettel of the Stab I./JG 2; Ofw Josef Wurmheller of 2./JG 2 and Uffz Heinz Dowhan of 1./JG 2. Of these four highly experienced battle-hardened fighter pilots, Hans-Jürgen Hepe was the only one to survive the war.***

"This is no joke . . . the English have landed at Dieppe!"

BELOW ***Meanwhile, on the other side of the Channel, Boston crews receive a briefing before a sortie to Dieppe on August 19, 1942. The Allied aerial bombing operations during Operation*** **Jubilee** ***were the responsibility of the RAF's No 2 Group, at that time commanded by Air Commodore Alan Lees.***

VIA AUTHOR

JEAN-LOUIS ROBA VIA AUTHOR

LEFT ***Showing the injuries he sustained on August 19, Hptm Erich Leie,*** **Gruppenkommandeur** ***of I./JG 2, gives a smile for the camera. The following year Leie served in the same role for I./JG 51 on the Eastern Front before being appointed*** **Geschwaderkommodore** ***of JG 77 in late December 1944. He was killed in action during combat with a Yak-9 on March 7, 1945.***

By 1000hr it was clear to the Allies that their landing had failed in the face of strong German Army resistance, and an evacuation order was given. However, this had no impact on the air fighting, which would continue to be ferocious for the next few hours.

The next mission by the I. Gruppe would also prove somewhat costly, as the determined RAF pilots defended the failed landing operation as best as they could. Although seven Spitfires were reportedly shot down between 1133hr and 1150hr, a number of JG 2 aircraft also failed to return to base. Having downed a Spitfire, Uffz Günther Brietz fell victim to anti-aircraft gunners and was posted missing. Similarly, Günther Seeger of the 3. Staffel downed a pair of Spitfires, but was hit and had to bale out of his Fw 190 coded "Yellow 14" with slight wounds. An even bigger blow was to be suffered by the Gruppe, however, as Erich Leie later wrote:

"While I covered an attack by my wingman on another Spitfire, I took hits in my fuselage and wings from behind and above. I immediately dived, and when I looked around, I noticed the presence of a Spitfire . . . Needing to land urgently, I spotted a field but saw the flat helmets of English soldiers who had taken refuge there. I regained altitude but 20km [12 miles] from Abbeville, smoke filled my cabin and my ammunition exploded. When I released the canopy, my aircraft was on fire. I baled out from 800m [2,600ft], but my face and right arm had been burnt by the flames."[5]

It would be six weeks before Leie returned to operations; his experience and leadership would be sorely missed for the rest of the day. The remainder of his Gruppe made it back to base, and were able to snatch a quick bite to eat.

A failed invasion

While there was action aplenty at Dieppe in the mid to late morning, Leopold Wenger had fetched a spare Fw 190 from St André and flown to Caen, before taking off from there at 1133hr with three comrades for the next Jabostaffel mission. He had vivid memories of the scene at Dieppe, where the Allied landing attempt was clearly a failure:

"When we arrived over Dieppe, the fighting zone was shrouded in mist, dust and dense smoke. The British fleet was completely hidden. Everywhere there were muzzle flashes and ashore you could see lots of fires from shot-down aircraft and burnt-out tanks which had hardly advanced more than 20m [60ft] up the beach. Many aircrew were floating in the sea in their rubber dinghies."

The Fw 190 fighter-bombers found targets among the chaos, and dived to attack with their 500kg bombs, strafing landing craft after their ordnance was released on warships. All four pilots returned to base unscathed despite heavy anti-aircraft fire and a brief tussle with some of the ever-present Spitfires.

Earlier in the year III./JG 2 had been given responsibility for the air defence of western France, and the 8. Staffel had been sent as far west as Guipavas on the Brest Peninsula. Nevertheless, the III. Gruppe still played a part in the German defence of Dieppe on August 19, with nine Fw 190s of 9./JG 2 taking off from Théville at 1105hr led by Staka Oblt Siegfried Schnell. They ran into dozens of Spitfires near Dieppe and became embroiled in low-level combat. Over the next 30min Schnell's men reported eight victories. One of those was claimed by Fw Heinz Pfeffer, who was himself downed and initially posted missing. In reality, he had baled out of Fw 190 "Yellow 5 + I", and landed near the coast, managing to swim ashore despite a leg injury. His eight comrades safely returned to base.

Luftwaffe bomber units had by this time been organised and took to the air, and from late-morning on, JG 2 was regularly given the duty of providing them with escort. In Luftflotte 3's review of the day's actions, the Geschwader was given a "pass" mark for its escort efforts. The

ANDY FLEXEN-PALLOT VIA AUTHOR

VIA AUTHOR x 2

ABOVE LEFT ***An uncharacteristically stern photograph of Ltn Franz Sommer of 6./JG 2, who was killed in action on August 19.*** **ABOVE CENTRE** ***Josef "Sepp" Wurmheller, one of the day's most successful fighter pilots, was killed when he collided with his wingman on June 22, 1944.*** **ABOVE RIGHT** ***Ltn Leopold Wenger of 10. (Jabo)/JG 2.***

higher headquarters noted the difficulty of the task on such a chaotic day, and pointed out that some overly keen bomber crews left their fighter protection to seek out targets by themselves, thereby exposing their aircraft to unnecessary risk. It should also be remembered that it had been a long time since JG 2 pilots had escorted bombers in daylight.

As the German bombers belatedly arrived at Dieppe around 1200hr, accompanied by Fw 190s of I./JG 2, the Allied evacuation was well and truly under way. It was also at this time that the 5. and 6. Staffeln of JG 2 began missions with eight and six aircraft respectively, both units reporting contact with numerous Spitfires and Mustangs to the north of the town. Among the victors was noted pre-war Austrian glider pilot Fw Wilhelm Ritter von Felgel-Farnholz, who opened his wartime account with a Spitfire, which crashed into the sea off Dieppe. He was awarded the *Eisernen Kreuz 2. Klasse* (Iron Cross 2nd Class) for this. However, Ltn Franz Sommer was posted missing during this operation, his Staka recalling many years after the war: "I can still remember Ltn Sommer — he was a strong, stocky man and was always in a good mood".[6]

Ship-hunting

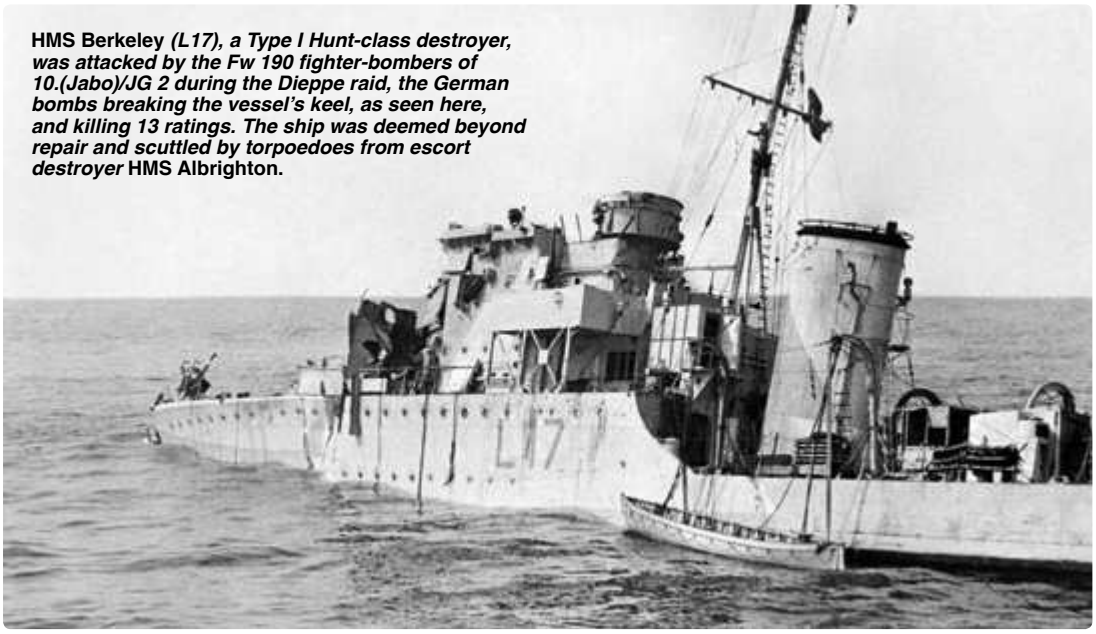
The evacuation from Dieppe ceased around 1330hr, leaving behind a chaotic scene. A JG 2 Jabostaffel pilot who visited the battlefield during the afternoon told his comrades how "the English [sic] had been scythed down by the dozen in front of the barbed wire on the beach by heavy machine-guns and mines". The beach was strewn with destroyed landing craft and tanks, and many wounded and dead Allied soldiers. The area was shrouded by smoke, both artificial and from numerous fires in the town.[7] Luftwaffe attention now shifted to the Allied vessels steadily making their way north and north-west towards England.

Soon after the last Allied vessel left Dieppe, Oblt Schröter, Ltn Wenger and two other Jabostaffel pilots were airborne from Caen and headed back to hunt for shipping. The anti-aircraft fire was ferocious again as they arrived over the target, and Schröter recalled: "A whole horde of Spitfires pounced on us", but they pressed home their ship attacks regardless. Wenger later wrote:

"I attacked a second destroyer and achieved a direct hit amidships with an SC 500 bomb. During the attack, I was under heavy anti-aircraft fire from the destroyer, but when the bomb went off, the guns stopped shooting. An explosion followed — simply disastrous. The whole ship was enveloped in black cloud but then I was chased and attacked by many Spitfires, and unfortunately could not watch the complete sinking."

Wenger's aircraft received substantial damage from British guns, with hits in the wing, engine, cowling, undercarriage, tail unit and cockpit. It is likely that Wenger's was the bomb which struck and damaged the 1,340-ton destroyer *HMS Berkeley*, which subsequently had to be torpedoed and sunk by another British destroyer.[8] This was the most significant anti-shipping success achieved by the Luftwaffe during Operation *Jubilee*, and cost the lives of 13 British sailors.

Mid-afternoon saw Bühligen lead 4./JG 2 to Dieppe for the third time, where he met British fighters at 3,000m (9,800ft); Ltn Theobald Eicher downed one and the pilot baled out, but the inexperienced *Gefreiter* Siegfried Eimers was shot down around 1515hr. The young German's body would wash ashore on a Dutch beach more than a month later.



VIA AUTHOR

HMS Berkeley *(L17), a Type I Hunt-class destroyer, was attacked by the Fw 190 fighter-bombers of 10.(Jabo)/JG 2 during the Dieppe raid, the German bombs breaking the vessel's keel, as seen here, and killing 13 ratings. The ship was deemed beyond repair and scuttled by torpoedoes from escort destroyer* HMS Albrighton.

After flying several smaller-scale missions around noon, I./JG 2 was back at Dieppe in strength, with a 3. Staffel mission between 1358hr and 1504hr, quickly followed by a 1. Staffel mission escorting Dornier Do 217s. During these two operations, five Spitfires were claimed destroyed and one German pilot was wounded. Wurmheller was successful yet again, accounting for two of the Spitfires, the latter at 1522hr after the German ace's attack from behind saw the starboard wing of the British fighter come off.

The 9. Staffel was also airborne from Théville shortly before 1400hr for its second mission of the day, during which Oblt Schnell and his men ran into a squadron of Bostons and numerous Spitfires, ranging from sea level up to 4,000m (13,100ft). Schnell claimed all three of his unit's victories on this occasion, his 68th to 70th, and witnessed one of the British pilots bale out of his burning aircraft. His achievements at Dieppe were highlighted a few days later in a newspaper article with the headline "Eichenlaub [Oak Leaf] Winner Shot Down Five Britons Near Dieppe".

Mid-afternoon action

At 1535hr the men of 7./JG 2 of the III. Gruppe finally saw some action, when "birthday boy" Oblt Egon Mayer, who turned 25 that day, led ten Fw 190s on an operation. They met the usual strong British air opposition. Mayer's combat report for his 52nd victory reads:

"At 1601hr I recognised three bombers in a fog bank just north of Dieppe. The bombers, flying at a height of 10m [35ft], were accompanied by a squadron of low-flying Hurricanes and Spitfires. I attacked the rearmost Hurricane at 1603hr from the closest range and fired on it with all my weapons. Immediately after being fired upon, the

VIA AUTHOR x 2

ABOVE LEFT *Egon Mayer in 1944. As the Staka of 7./JG 2, Mayer celebrated his 25th birthday over Dieppe by claiming several of his 102 victories.* ABOVE RIGHT *Erich Rudorffer, Staka of 6./JG 2 on August 19, 1942, survived the war having accrued a remarkable 222 aerial victories; he was shot down some 16 times.*

Hurricane crashed into the water at a shallow angle and was completely destroyed."

A Spitfire fell to the German ace's guns soon afterwards, and Willi Stratmann accounted for another. Accompanying 7./JG 2 was the *Höhenstaffel*, 11./JG 2, with its high-altitude Bf 109G-1s. One of the unit's veteran pilots, *Stabsfeldwebel* Erwin Kley, was killed in a forced landing at the end of the mission. His loss was keenly felt by his comrades, Staka Julius Meimberg later writing:

"We were all hard hit by the death of Stabsfeldwebel Erwin 'Icke' Kley, who had come with me from the 3. Staffel to the 11. Staffel. Kley, who claimed the first aerial victory of the Richthofen Geschwader in the war, was hit by fire from a single Spitfire on his return flight from our third mission, and had to make an emergency landing.

MORTEN JESSEN VIA AUTHOR

Focke-Wulf Fw 190A-2 "White 7 + I" of 7./JG 2's Staka Oblt Egon Mayer is refuelled for another sortie in France in the summer of 1942. By the end of 1942 Mayer and his III. Gruppe comrades would be at the forefront of the German defence against American heavy bombers, as the USAAF's B-17s and B-24s targeted objectives in western France.

We heard him announce that he was hit, followed by the calm announcement that he would attempt to belly-land on the beach at Le Tréport."[9]

Things did not go according to plan, however: after striking an obstacle just after touching down on the beach, Kley's Bf 109 overturned, breaking his neck.

The II. Gruppe was able to send out one final mission with as many aircraft as it had available. A total of 19 Fw 190s took off from Beaumont-le-Roger at 1607hr and engaged in a mid-Channel duel with between 20 and 25 Spitfires. Some Do 217s of II./KG 40 had just completed an attack on British ships and been intercepted by fighters, and Ltn Bühligen and Oblt Erich Rudorffer were able to down a pair of Spitfires each. The unit then returned to base, and that evening sent its pilots and aircraft to dispersal airfields. The four aircraft lost by the II. Gruppe in exchange for 26 victory claims was one of the best victory-to-loss ratios of any German *Jagdgruppe* on August 19, 1942.

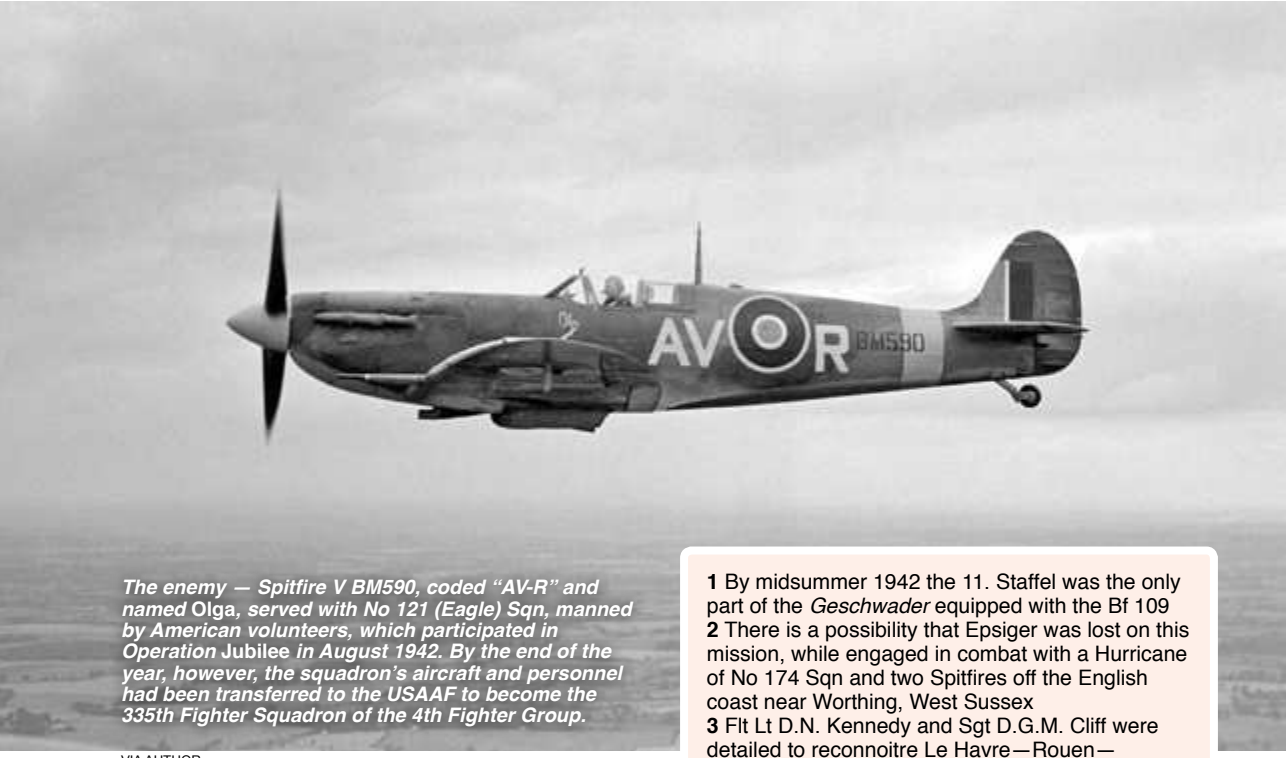
Aerial combats wound down as the British vessels approached their harbours, but JG 2 would enjoy a few final successes. Ten Fw 190s from the I. Gruppe took off at 1652hr and undertook strafing attacks on British vessels north of Dieppe, with one boat exploding from the rounds of an Fw 190. Spitfires were also met, and the indefatigable Wurmheller downed yet another, the 56th victory of his career. Pilots of the Gruppe would conduct a final mission towards dusk, helping with search-and-rescue efforts in the Channel, and then flew to their dispersal fields at Rouen-Boos and Dreux after a successful but costly day.

The Jabostaffel flew a final mission from Caen in the evening, this time against vessels off the English coast. There were no more live targets left at Dieppe, and the British landing fleet had almost made it back across the Channel. The 10.(Jabo)/JG 2 fighter-bomber pilots claimed hits on ships off Brighton. The unit's total claims on a very successful day were two destroyers, two large landing craft and two escort ships sunk, a Spitfire shot down and one destroyer, one cargo ship, one landing ship and two escort ships damaged. Of course, given the confusion of combat, these claims were a little optimistic, but there is no doubt that the Jabostaffel had played its part in the German success at Dieppe. Luftflotte 3 praised the unit, noting that "Jabostaffeln, particularly 10.(Jabo)/JG 2, did splendid service . . .".

The day's tally

Jagdgeschwader 2 submitted 67 victory claims for the day, 60 of which were subsequently confirmed. In exchange, the unit lost eight pilots killed or missing, plus eight wounded, as well as 15 aircraft destroyed or written off. Even allowing for the typically optimistic claiming of fighter pilots, it was a clear victory for the Richthofen Geschwader.[10] However, it had been a difficult day, as one Staka recalled: "The [Allied] fighter protection was very strong. It was a very tough fight for our unit."[11] There were usually only a few personnel casualties per week for the Geschwader, so 16 in a single day was a big blow. Jagdgeschwader 26 had also been active throughout the day, but claimed only 38 victories and suffered fewer losses.

Thus ended an incredibly busy but victorious day for JG 2. Not since the Battle of Britain had



The enemy — Spitfire V BM590, coded "AV-R" and named* Olga*, served with No 121 (Eagle) Sqn, manned by American volunteers, which participated in Operation* Jubilee *in August 1942. By the end of the year, however, the squadron's aircraft and personnel had been transferred to the USAAF to become the 335th Fighter Squadron of the 4th Fighter Group.

VIA AUTHOR

the German pilots participated in such intense aerial combats. The unit suffered some significant losses, and each of those men would be sorely missed by their comrades; but the victory-to-loss ratio was very much in favour of the Richthofen Geschwader on August 19.

Conversely, the Allies reported a total of 106 of their aircraft shot down, including 88 fighters, many of which had fallen to the guns of JG 2. The German pilots of the Richthofen Geschwader, in their swift and powerful Focke-Wulf 190s, had been able to use their weapon to deadly effect on a day of brutal air-to-air combat.

ACKNOWLEDGMENTS *The author would like to thank Russell Fahey, Andy Flexen-Pallot, Chris Goss, Russell Guest, Morten Jessen, Ken King, Erik Mombeeck, Jim Perry, Jean-Louis Roba, Adam Thompson and Rémi Tracanelli for their help with the preparation of this article*

1 By midsummer 1942 the 11. Staffel was the only part of the *Geschwader* equipped with the Bf 109
2 There is a possibility that Epsiger was lost on this mission, while engaged in combat with a Hurricane of No 174 Sqn and two Spitfires off the English coast near Worthing, West Sussex
3 Flt Lt D.N. Kennedy and Sgt D.G.M. Cliff were detailed to reconnoitre Le Havre—Rouen—Abbeville—mouth of the Somme—Le Havre from 0615hr, but both failed to return
4 Mombeeck, E., with Roba, J-L, *Dans Le Ciel de France, Histoire de la JG 2 "Richthofen", Vol 3: 1942,* ASBL La Porte d'Hoves, Linkebeek, undated, p146
5 ibid, p148
6 Rudorffer, E., letter of June 28, 1999
7 The British made extensive use of smoke-laying during the operation to shield the landing force and ships
8 A British report on the raid noted that *HMS Berkeley* was hit by "a bomber jettisoning its bombs", but most sources suggest an Fw 190 Jabo was responsible
9 Meimberg, J., *Feindberührung, Erinnerungen 1939–1945*, NeunundzwanzigSechs Verlag, Moosburg, 2002, p217
10 A ratio of two victory claims to every actual loss was normal for Second World War aerial combat
11 Mombeeck, op cit, p150

JG 2 victory claims and losses— August 19, 1942

Unit	Total claims	Confirmed	Pilots KIA or MIA*	Pilots wounded	Aircraft Destroyed or Written Off
Stab JG 2	—	—	—	—	—
I./JG 2	26	24	4	3	8
II./JG 2	26	24	3	3	4
III./JG 2	13	12	—	2	1
10.(Jabo)/JG 2	1	—	—	—	—
11.(Höhe)/JG 2	1	—	1	—	2
Total	**67**	**60**	**8**	**8**	**15**

*KIA = Killed in action MIA = Missing in action

ARMCHAIR AVIATION

We take a look at what's available for the aviation history enthusiast in the world of books and other literature, from hot-off-the-press publications to reissued classics

Alarmstart South and Final Defeat: The German Fighter Pilot's Experience in the Mediterranean Theatre 1941–44 and Normandy, Norway and Germany 1944–45

By Patrick G. Eriksson; Amberley Publishing, The Hill, Stroud, Glos, GL5 4EP; 6¼in x 9¼in (159mm x 235mm); hardback; 320 pages, illustrated; £20. ISBN 978-1-445693-32-3

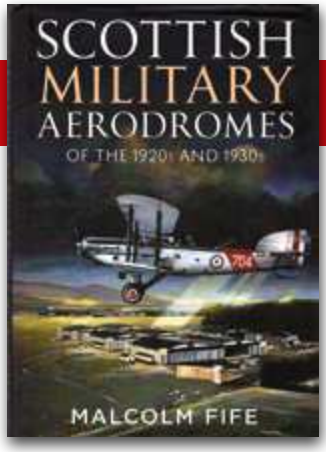
AS WE PASS the 75-year mark since the end of the Second World War, it becomes increasingly rare to find fresh recollections from airmen from any of the belligerent powers. We have reached the point where authors' and researchers' reliance on documents and archival sources has probably surpassed their ability to find new personal accounts as the prospect of locating veterans able and willing to recollect and commentate slips away. With this being the case, it was refreshing and enjoyable to read Patrick G. Eriksson's third volume in his Alarmstart trilogy.

Alarmstart South and Final Defeat tells the story of, as the cover describes it, "the German fighter pilot's experience in the Mediterranean theatre 1941–44 and Normandy, Norway and Germany 1944–45". Professor Eriksson, a former departmental head at the University of Pretoria, was able to spend time during official trips to Germany meeting Luftwaffe fighter pilot veterans when they gathered in their so-called *"Jägerkreis"* (fighter meets/circles). The results of his meetings, interviews and copious correspondence form the narrative thread through this well-written, absorbing and informative book. What makes the book balanced is that Professor Eriksson not only sought out senior officers, unit commanders and "aces" such as Gustav Rödel, the *Kommodore* of JG 27 and a holder of the Knight's Cross with 98 victories, but also a host of lesser-known pilots who may not have equalled the scores and accomplishments of their illustrious *Experten*, but who nevertheless flew, fought and experienced just as much of a war as they did, as the recollections in this book evocatively testify.

Eriksson describes no fewer than nine campaigns or theatres of war, each presented in a chapter: the Balkans, the Western Desert, Malta, Tunisia, Sicily and Italy, south-eastern Europe during 1943–44, Normandy, the defence of the Reich and, perhaps a little curiously, the campaign in Norway; for the Luftwaffe, a mix of success and reverses. The strength of the book lies in the fact that the author comfortably and coherently blends a grasp of the respective strategic situations in each campaign or theatre, together with snapshots of Allied air activity and how individual Luftwaffe units and pilots dealt with being outnumbered, outgunned and hamstrung by high losses — scenarios enriched by the inclusion of their own words. By the summer of 1944, for example, the Luftwaffe's fighter pilots in the West were engaged not just in a relentless campaign to defend "Fortress Europe" against the might of the strategic Allied air forces, but more immediately, in a struggle to stay alive. The odds were against them, as *Hauptmann* Ernst Schröder, *Gruppenkommandeur* of III./JG 2, recalled of a "typical" encounter over Normandy in which he fought on his own, in his Fw 190, in a dogfight against no fewer than seven P-47s. Somehow he survived; but with odds like that, the writing was on the wall. The carnage that the *Jagdflieger* experienced in France must have seemed a world away from the heady days of the German advance into the Balkans.

And there is much anecdote: in November 1944, for example, *Oberleutnant* Hans Grünberg was posted to fly the Me 262 jet fighter with 1./JG 7 as its *Staffelkapitän*. He related to Eriksson that as his unit awaited the arrival of the fast and heavily-armed new interceptor on which was placed so much hope of making an impact against the USAAF's heavy bombers, his pilots kept their "shooting eyes" keen by hunting rabbits and hares every morning and evening.

If you are looking for one book that will supply



you with a well-crafted, diligently researched, highly graphic introduction to the German fighter pilots' war between 1941–44, this is it.

ROBERT FORSYTH

BE2a: A Definitive History

By Paul R. Hare & Andrew Willox; available direct from the publisher, Aero History, e-mail aerohistory@skymesh.com.au (please mention The Aviation Historian *when ordering); 10½in x 10½in (265mm x 265mm); hardback; 192 pages, illustrated; £30 inc 2nd Class p&p in UK. ISBN 978-0-646813-86-8*

FOR THE TRUE enthusiast, there is something rather joyous in not just having a book about the Royal Aircraft Factory's B.E. series of biplanes (B.E. = Blériot Experimental, i.e. tractor propeller rather than pusher); and not just a book about the B.E.2 and its several variants; but a book devoted solely to just one of those variants (and certainly not the best-known or most-produced, although it did have its own claims to fame): the B.E.2a. This slim, square-format volume fulfils the promise made on its front cover.

Paul Hare is widely regarded as "Mr B.E." and the leading authority on the Royal Aircraft Factory in general; and about six years ago Andrew Willox completed his carefully-researched and accurate replica B.E.2a for the RAAF Museum at Point Cook. Between them they have created (and self-published — hurrah!) an engaging and pacy history, generously illustrated with mostly huge photographs which really draw the reader visually into the 1912–15 period and thereabouts. Although some of the images are enlarged far further than they can stand, becoming pixellated or just plain fuzzy, others possess that every-blade-of-grass crispness that only large glass-plate negatives can deliver.

After some introductory and scene-setting chapters, just over half the total pagination is given over to individual aircraft histories by serial number. These are followed by chapters on very specific historical topics such as Capt C.A.H. Longcroft's long-range proving flights between Farnborough and Montrose in Scotland; a single B.E.2a bought for India with a view to setting up a military flying school there; and the final surviving original B.E.2as — a pair belonging to the RAAF Central Flying School, which survived into 1918.

Further chapters follow, some contributed by external specialists, looking at technical details such as the aircraft's aerofoil sections, engines and propeller, and replicas.

Why choose the B.E.2a for this definitive treatment? As the authors say in their introduction, when World War One broke out the aircraft was the single most numerous type in Britain's decidedly mixed military aerial fleet; and it held the record for distance flown, thus indicating capability and reliability. It was a decent start.

MICK OAKEY

Scottish Military Aerodromes of the 1920s and 1930s

By Malcolm Fife; Fonthill Media; Millview, Toadsmoor Road, Stroud, Glos GL5 2TB; 7in x 10in (180mm x 255mm); hardback; 207 pages, illustrated; £25. ISBN 978-1-781557-65-5

THE CESSATION OF the First World War — which had led to a major expansion in the development of military aerodromes across Scotland and along its coastline — brought about a rapid contraction of the size of the newly formed RAF and its facilities, all but two of its Scottish aerodromes (Donibristle and Leuchars) being shut down within a year of the Armistice.

This book, illustrated with more than 80 photographs (many sourced from Scran — a digital-archive service of Historic Environment

Scotland), traces the evolution of Scottish military aviation during the subsequent inter-war years, focusing in particular on case studies of the RAF bases at Leuchars, Donibristle, Turnhouse, Novar (renamed Evanton from November 1936) and Montrose on Scotland's east coast and Abbotsinch and West Freugh on the west, the latter developed as part of the RAF expansion programme initiated from 1934 in response to the changing international climate. More RAF aerodromes were subsequently opened in 1939 at Drem, Kinloss and Lossiemouth and RNAS Hatston for the Fleet Air Arm (FAA), which became independent of the RAF in May 1939 when it came under the control of the Royal Navy.

As the story of each airfield unfolds, similar patterns emerge of the initial struggle between civil landowners and the military for control of the land, the changing requirements of airfields from pilot training and aircraft maintenance/support and serving as formative bases for the Auxiliary Air Force (AAF) formed in October 1924, and the transition from biplanes to monoplanes.

Throughout the book numerous aircraft accidents and incidents are recorded, although without a wider context being provided it is difficult to know whether these were due to local geography, weather conditions or pilot error. It not until page 136 that biplanes are described as being "very susceptible to sudden gusts of wind" while landing, among other possible scenarios. Similarly, in each airfield's year-by-year account the flying programme for Empire Air Day is recorded (which perhaps should have been included as a series of appendices), but it is not until page 132 that the reader is informed that it was a public event held from 1934, organised by the Air League of the British Empire in association with the Air Ministry.

The volume concludes with interesting chapters — which perhaps should have been placed at the beginning, as they provide context for the Scottish aerodromes that supported them — surveying the evolution of the RAF's flying-boat operations, mainly along the Firth of Forth, Loch Ryan, Cromarty Firth, Firth of Tay, Oban and Stornoway, and the Scottish operations of the aircraft carriers *HMS Argus, Furious, Courageous* and *Hermes*, concluding with the submarine-based Parnall Peto (incorrectly spelt "Parnell" on various pages), the catapult-launched Fairey IIIF and radio-controlled de Havilland D.H.82 Queen Bee target aircraft.

A lot of information is presented here. Nevertheless, the book's value as a work of reference could have been greatly enhanced with the inclusion of an index to all the numerous names, places, aircraft and squadrons recorded; also the inclusion of more detailed local maps to inform the unfamiliar reader as to where exactly these aerodromes were would have been a welcome addition.

BRIAN RIDDLE

Spying From The Sky — At the Controls of US Cold War Aerial Intelligence

By Robert L. Richardson; Casemate Publishers (www.casematepublishers.com); 6¼in x 9¼in (160mm x 234mm); hardback; 302 pages; illustrated; £25. ISBN 978-1-612008-36-4

FOR DECADES THE history of Cold War strategic aerial reconnaissance was heavily classified, and the few bits that were available dealt primarily with Francis Gary Powers and his Lockheed U-2. Fortunately, the passage of time has resulted in the declassification of many primary documents and seen an increase in the willingness of many participants to tell their stories. *Spying from the Sky* benefits from both.

Richardson's book is a unique blend of Cold War history and autobiography of Col William

Flyleaves / Classic aviation books revisited

The Flying Omnibus. Edited by Paul Jensen; Cassell & Company Ltd, 1953; 5½in x 8in (140mm x 200mm); Hardback; 338 pages; typical price around £5–£10

"THIS FEAST FOR the air-minded reader", as the dustjacket promises, begins with Edgar Allan Poe's *The Balloon-Hoax* (a spoof transatlantic flight first published in the *New York Sun*, April 13, 1844) and concludes with Murray Leinster's *First Contact* (from *Astounding Science Fiction*, May 1945) in which "a solitary Earth-ship and a solitary alien" meet in the Crab Nebula, where "neither dared return to its home base if the other could do harm to its race". Fiction is strongly represented in this anthology of "the literature of aviation", with contributions from John Dos Passos, H.G. Wells, James Thurber, Roald Dahl, H.E. Bates and Eric Knight, the short stories alongside extracts from autobiographies (including Francis Chichester, Antoine de Saint-Exupéry and Anne Morrow Lindbergh among others), short historical reviews (the Montgolfiers, Zeppelins and the Dam Busters raid) and speculations on the mysteries of flight. From this "hodgepodge" the reader will uncover literary gems such as Wells's *My First Aeroplane* and Knight's *The Flying Yorkshireman* amid experiences of flying while at war and in peace. **BRIAN RIDDLE (former Chief Librarian, Royal Aeronautical Society)**

J. Gregory, USAF (retd). Beginning with his early life, it recounts Gregory's experiences at pilot training during the Second World War; his assignment to P-38s and combat duty; his post-war recall to Strategic Air Command (SAC) as a KB-29 tanker pilot; subsequent assignment to B-47s and then his induction into the reconnaissance world with the RB-57D. Then comes his secondment to the CIA and command of U-2 Detachment G at Edwards AFB in California, concluding with his final years in military leadership roles. The book is well illustrated, extensively footnoted with primary and secondary sources, and eminently readable.

The general details of Cold War reconnaissance history have been well chronicled by Kevin Wright in *The Collectors* (Helion, 2019) and other authors, and the history of the U-2 superbly recounted in *TAH* contributor Chris Pocock's *50 Years of the U-2* (Schiffer, 2005). Richardson's summary is well done, but adds little new material to this existing literature. Its value lies in establishing the context for Gregory's career and his insight into the many key events that defined the Cold War.

Gregory's recollections are inserted *en bloc* throughout the book, and make for fascinating reading. His memories of the RB-57D *Border Town* missions, for example, add to our understanding of the growing importance of electronic intelligence (ELINT). It is the material on Det G operations that proves most illuminating, including an anecdote about the change in the cover story for U-2 overflights of Cuba in October 1962 that prompted the shift from the CIA to SAC flying the missions during the height of the Missile Crisis. Gregory's unique position as a USAF officer commanding the CIA detachment facilitates the more balanced view that it was the combined effort of CIA personnel and aircraft flown by SAC pilots that provided the critical intelligence that informed President John F. Kennedy during the crisis.

Some of the illustrations are disappointing, borrowed from Wikimedia and too small to be useful to see the details mentioned in the captions (p172). There are a few places where word choice leads to misinterpretation or error. Richardson notes that the April 1954 shootdown of the *Roman I* RB-47B was "over" the Kamchatka Peninsula. In fact, it was not an overflight but a peripheral mission well offshore over the Pacific Ocean (p158).

Overall, however, this is a fine addition to the growing body of high-quality literature on Cold War aerial reconnaissance.

ROBERT S. HOPKINS III

Orly: Aéroport des sixties (A Sixties Airport)

By Paul Damm, English translation by Paul Smith; Editions Lieux Dits, Lyon, France (www.lieuxdits.fr); 9½in x 11½in (243mm x 290mm); hardback; 176 pages; illustrated; €29 + €4.40 p&p to UK. ISBN 978-2-362191-66-4

SIXTY YEARS AGO, on February 24, 1961, French President Charles de Gaulle officially opened the state-of-the-art terminal at Paris-Orly Airport, originally conceived in the late 1940s as France's main air gateway and hastily adapted to accommodate jetliners with the coming of the turbine era. This magnificent coffee-table book (although also a great deal more than that) tells the full story of the airport in French and English, the side-by-side format detailing its First World War origins, through its glory years in the 1960s, to its present-day use as a busy airport for predominantly domestic services.

With wonderfully evocative vintage colour photographs, memorabilia and airport layout diagrams throughout, this is an absolute treat for those interested in the space where aviation, architecture, engineering, vernacular design and social history intersect. Heartily recommended.

NICK STROUD

BOOKS IN BRIEF

A quick round-up of what else is currently available for the aviation history enthusiast

AGAINST ALL ODDS
Air Commodore Kaiser Tufail
Helion & Co; ISBN 978-1-913118-64-8; £16.95

SUBTITLED *THE PAKISTAN Air Force in the 1971 Indo-Pakistan War*, the 12th in Helion's *Asia@War* series of 8¼in x 11½in softbacks does exactly what it says on the tin. It describes the two-week conflict between Pakistan and neighbouring India in December 1971, which culminated in the establishment of Bangladesh as a separate state. Focusing on the Pakistan Air Force (PAF) perspective, the author, a former PAF fighter pilot himself, acknowledges the difficulties of separating fact from propaganda in such high-temperature political environments, but presents a lucid and admirably even-handed account of the jet-on-jet air combats of this brief but historically significant clash of arms. **NS**

MYSTERY OF MISSING FLIGHT F-BELV
Stephen Wynn
Pen & Sword Aviation; ISBN 978-1-473845-95-4; £19.99

ON OCTOBER 18, 1965, Boeing 307 Stratoliner F-BELV, operating with the International Commission for Supervision & Control (ICSC) in south-east Asia, failed to arrive at Hanoi after departing Vientiane in Laos. Neither the aircraft nor those aboard were ever heard from again. One of the latter was the uncle of the author of this 128-page hardback, the blurb on the back of which asks "What happened to Flight F-BELV? Did it crash or was it brought down? Why and where?" Unfortunately, none of these questions is answered, and the journey to that rather unsatisfying conclusion is one of awkward grammar (pronouns are a particular problem), typos ("Phatet Lao") and an annoying habit of referring to the aircraft as "Flight F-BELV". There's a good story at the heart of this book, but it is in dire need of a competent and knowledgeable editor. **NS**

AIRFRAME ALBUM No 16: THE MESSERSCHMITT Me 410 HORNISSE
Richard A. Franks
Valiant Wings Publishing; ISBN 978-1-912932-13-9; £19.95

SUBTITLED *A DETAILED Guide to the Last Zerstörer,* this 164-page A4 softback is a welcome history and description of the Luftwaffe's heavy fighter. Five chapters encompass its conception, testing, production and operational use; a technical description; the type's evolution, depicted in isometric drawings; projected and increasingly desperate late-war developments; camouflage and markings; and a 1/48th-scale kit build. Satisfying stuff. **MO**

AIRFRAME & MINIATURE No 16: THE HAWKER HURRICANE
Richard A. Franks
Valiant Wings Publishing; ISBN 978-1-912932-12-2; £24.95

A PROPERLY crowd-pleasing choice of subject for the 60th book produced in its ten years of existence so far, Valiant Wings's Hurricane monograph devotes a hefty 270 pages to the iconic fighter. Aimed at modellers and detail fanatics, it unravels the bewildering differences between all the many variants and sub-variants (more than you'd think — about 90!) with the help of copious photographs, colour and mono profiles, isometric views and more, including fine quadruple-gatefold 1/48th-scale drawings by Richard J. Caruana. It also features masterful kit-builds and kit/accessory listings. **MO**

COLD WAR DELTA PROTOTYPES
Tony Buttler
Osprey Publishing; ISBN 978-1-472843-33-3; £13.99

IN THE 15th volume in Osprey's *X Planes* series, respected author and *TAH* contributor Tony Buttler takes a look at British and American delta-winged experimental jets, mainly sticking to the developments of Fairey to represent the former and Convair the latter. The final section on the Avro 707s feels bolted-on in an effort to shoehorn in experiments into delta bombers too. And therein lies a small issue, in that the title *Cold War Delta Prototypes* is ill-chosen; any such book would surely have to include the French, who finessed the concept into an art form with the Mirage series. Despite the misleading title, this is well up to the author's usual high standard. **NS**

WARPAINT 128: BRISTOL SCOUT
Matthew Willis
Guideline Publications; No ISBN; £14

NEVER REGARDED alongside Britain's "star" fighters of World War One, the Sopwith Camel and the Royal Aircraft Factory S.E.5/5a, the Bristol Scout has always been a supporting actor in the history of air combat. This is a shame, because quite apart from its light, perky lines and agile handling, it did play a significant role: as the author says, at the beginning of the war it "set the pattern for how a 'fighting scout' would look and fly". This useful and meticulous 44-page A4 monograph does its subject overdue justice. **MO**

Lost & Found

***PHILIP JARRETT** explores the lesser-known corners of aviation history, discovering little-known images and rediscovering long-lost details of aircraft, people and events. This time he asks for information about a novel refuelling system at de Havilland's Stag Lane airfield*

THESE IMAGES, from a collection of six which I acquired last year, depict de Havilland D.H.60G Moth G-AADI of the de Havilland School of Flying being refuelled at Stag Lane Aerodrome. Issued with its Certificate of Airworthiness in February 1929, this Moth joined the school in June 1930. The interesting thing about these images is that they depict a refuelling system using an underground fuel tank fitted with a retractable pipeline that was housed under hinged covers in the concrete surface above the tank.

Stuart McKay of the de Havilland Moth Club was completely unaware of the existence of this facility until he saw these images. He comments: "The multi-bay building in the background of the main picture is the de Havilland Service Department. The buildings were among the last to be erected on the aerodrome, and the first to be dismantled when the site started running down. In the background on the left is the first row of 'Moth Garages' to be erected after the idea was unveiled in about 1928, when the first block was opened with great fanfare next to the original location of the London Aeroplane Club. The new block was doubled in size and extended to the west [left in the picture]. The pavilion which can be seen on the right [in the other picture] is the HQ of the London Aeroplane Club, which had been moved from quite close to where this action was taking place. I can't say I have ever seen reference to an underground fuel supply at Stag Lane. I wonder if it was discontinued? Draping the fuel hose over a potentially hot exhaust couldn't have been the best idea. It's an interesting arrangement altogether".

Any further info from readers would be most welcome.

ABOVE & BELOW *Two of the photographs acquired by the author showing a little-known and perhaps short-lived innovation for refuelling light aircraft at de Havilland's Stag Lane airfield in the early 1930s. Seen above is the pipeline after being raised from its housing in the concrete surface covering the fuel tank, and below, an engineer refuels Moth G-AADI using the system.*

“A very nasty situation…”

A CLOSE SHAVE FOR BAC ONE-ELEVEN G-ASJC, MARCH 1981

In March 1981 British Caledonian BAC One-Eleven G-ASJC arrived at Gatwick with a nosewheel niggle. Following an inspection, “Juliet Charlie” was halfway through a high-speed test run with minimal fuel and no ballast when she unexpectedly lurched into the air. **TOM SINGFIELD** describes how cool heads in the cockpit avoided a potential disaster

PETER KEATING © A FLYING HISTORY LTD

B. NICHOLLS VIA AUTHOR

BAC One-Eleven G-ASJC, seen here at Gatwick in June 1973* (MAIN PICTURE) *and May 1972* (TOP), *was one of eight Series 201ACs inherited by British Caledonian when it was formed with the merger of British United Airways and Caledonian Airways in November 1970, and with which it was named* City of Glasgow. *The airline also took on eight Series 501EXs and four Series 509s at the same time.

BRITISH CALEDONIAN'S BAC One-Eleven Series 201AC G-ASJC (c/n 007) was the fourth example of the type to fly, making its maiden flight from Hurn in April 1964, before delivery to Gatwick for service with British Caledonian's predecessor, British United. It flew for British Caledonian (BCal) for ten years before being sold in the USA in 1981 — but it could well have been destroyed in a serious incident at Gatwick on March 6 the same year. The story of this incident has been gathered from multiple sources, including the air traffic control (ATC) staff on duty in the tower, airport workers who witnessed it and official reports by the crew to both BCal and the Civil Aviation Authority (CAA). The memories of some who were there that day differ, but the author believes the following is the correct version of events.

Undercarriage problems

"Juliet Charlie" arrived at Gatwick from Brussels on March 5, 1981, and was towed to the BCal hangars at 1620hr to have its nose undercarriage checked after crews had reported wheel-shimmy problems. It was jacked up in the hangar and checked over. Exactly what, if any, rectifications were made is unknown; but it was decided to perform a taxying test to check for serviceability. Captain John Vetch, a highly regarded and skilled pilot, at that time Senior Training Captain on the BCal One-Eleven fleet, was tasked with the test, to be accompanied by engineer Tony "Ace" Archer (A.C.E. Archer) in the copilot's seat and engineer Peter Dawes as an observer. The aircraft was given fuel for 15min, but although it was virtually empty and consequently tail-heavy, it was not ballasted. Normally if the One-

ALLEN WATKIN

ABOVE ***The One-Eleven's nose-wheel was steered by means of a tiller located in a panel to the left of the pilot's seat, as seen here; it was replicated to the right of the copilot's seat. The instrumentation on the One-Eleven's flightdeck*** **(RIGHT)** ***was conventional, with throttle and trimming controls incorporated into a central pedestal. This is the cockpit of Series 400 G-ASYD at Brooklands.***

ADRIAN BALCH

ABOVE ***British Caledonian was a major user of the One-Eleven on its routes to Europe and later to North Africa. This aircraft, Juliet Charlie's sister aircraft G-ASJH (c/n 012), also joined the BCal fleet from British United, and like 'SJC, served the airline for more than a decade before being sold to American operator Pacific Express in 1982.***

MIKE HOOKS

ABOVE ***One-Eleven 523FJ G-AXLL* City of Aberdeen *joined the BCal fleet in late 1983, and is seen here in June 1987 in the slightly revised colour scheme that 'SJC would have been wearing during its "hairy moment" at Gatwick in March 1981. The scheme was essentially the same, but with a different style of legend lettering on the fuselage.***

Eleven was to be operated empty, or even towed empty, 300kg (730lb) of ballast would be placed in the front hold, hard up against the forward bulkhead — a job which was apparently not popular with the ground staff!

The One-Eleven was taxied across the runway and down to holding point "Echo" at the far western end of the airport, where full 360° turns were made to check the steering, controlled by use of the tiller. Vetch mentioned to the engineers that on cancelling a large tiller input left or right, the aircraft would continue to drift slightly in the direction of the last input unless the tiller was turned back past the neutral position. This was not considered to be a major problem, but while taxying back towards the hangar, Vetch asked ATC if he could speed up to see how the steering behaved, which was agreed.

"Aircraft accident imminent . . ."

Obviously not happy with the fast run along the taxiway, Vetch asked ATC if a high-speed run could be made along the runway. Approval was given, and with Vetch handling the tiller and throttles, the One-Eleven was lined up on Runway 26, the run commencing at 1040hr local time. Vetch planned to steer the aircraft using the tiller up to a maximum of 80kt — but, before that speed was reached, the nosewheel began to shimmy. Vetch took hold of the control column and pulled back a little to stop the shimmy, but with no flaps set and an aft centre of gravity (c.g.), the nose pitched up dramatically and the rear fuselage scraped along the runway as the aircraft lifted off in a severely nose-high attitude. Observers in the terminal reported that theirs was almost a plan view of the airliner as it struggled into the air. The starboard wing dropped, and, with the aircraft barely flying, Vetch applied full throttle and skilfully managed to keep it in the air.

In the visual control room (VCR), controller Graham Wilson and his assistant Janet Hartell watched in horror as the One-Eleven continued in a turn to starboard, missing the original 1958 tower by 100ft (30m). Wilson hit the red emergency 'phone button and declared "aircraft accident imminent", which alerted the fire service and other airport authorities.

Inside the One-Eleven, Vetch fought to get the aircraft under control while the stick-shaker and stall-warning horn added to his distractions. Once the aircraft's attitude was stabilised, Vetch continued the starboard turn to fly downwind for Runway 26. At this point it is not thought he declared an emergency, as he thought that a normal circuit and landing would follow. However, when the One-Eleven flew past the tower, a security man on the gate noticed that the nosewheel unit appeared to be at 90° to the axis of the fuselage. He ran into the approach control room and alerted ATC, which relayed the information to the tower controller, who was now watching Juliet Charlie stagger towards Horley downwind for Runway 26.

Vetch was informed about the nosewheel unit but with so little fuel aboard he did not have the luxury of holding off while the crew sorted it out. In an effort to confirm the status of the nosewheel, he flew a tight circuit and overflew the runway so that ATC and aircrew of the aircraft holding for departure could visually check the nosewheel unit's alignment. In Archer's subsequent report he said that he

AUTHOR'S COLLECTION

ABOVE ***Still with its UK registration but in its new Pacific Express colours, c/n 007 is seen here before its delivery to its new owner at Gatwick on December 10, 1981. It served the airline as N101EX until early 1984, before going on to be operated by Air Wisconsin, Florida Express, Braniff, Air Tara (as EI-BWI). it was finally broken up in early 1994.***

"glanced at the F/O's tiller and saw that a left-turn input was still on the tiller. I moved the tiller back to neutral without undue force and it remained there". The nosewheel unit, however, remained out of alignment, so Vetch briefed the engineers that he would fly a circuit over Crawley to the south of the airport, land while holding the nose up as long as possible and shut everything down on the runway. Archer, who was a very switched-on engineer, was told to shut down the auxiliary power unit (APU) on approach, help Vetch with the landing checklist and monitor the speeds; he was also told to close the high-pressure (HP) cocks and pull the fire handles after landing. With the crew well-briefed and an experienced captain at the controls, the One-Eleven touched down safely minutes later.

Differing stories

Reports differ somewhat regarding the reason behind the nosewheel unit misalignment. In normal operation, the nosewheels are centralised before retraction by an internal cam in the nose oleo that operates when the oleo extends after take-off. It would appear that the undercarriage remained extended during the entire incident, so had groundlocks been fitted for the taxying test? Archer's report stated that groundlocks were fitted after landing. The tower controller told the author that a nosewheel tyre (or tyres) burst on landing and that the crew evacuated using the cockpit ropes, but this has not been confirmed by any other sources. Archer's report also stated that all three aboard were strapped in but at least two others said that observer Dawes was slightly injured after he fell backwards during the rotation as he was not strapped in. The full story may never be known, as Vetch died in 2012, one engineer is now in a home and the other has since died.

The One-Eleven was eventually towed off the runway and taken to Hangar 3, where the damage could be assessed. The ventral stairs had been substantially flattened and the aft drain mast had been worn away during the over-rotation. What damage was done to the nosewheel unit is not known. Repairs were completed by March 12, when the aircraft undertook a successful 15min test flight, followed by BCal's BR824 service to Amsterdam that evening.

Juliet Charlie moves on

In December that year, G-ASJC was sold to Pacific Express Airlines as N101EX in the USA and later served with Air Wisconsin, Florida Express and Braniff, before becoming EI-BWI and ending its days with 45,798 hours on the clock on the scrap pile at Southend in 1994, after spares reclamation by British Air Ferries.

After the unintended flight, Vetch, who later became BCal's One-Eleven Fleet Manager, wrote in the aircraft's Tech Log: "Became airborne for *x* minutes inadvertently". The crew was interviewed by BCal management at a "no tea . . . no biscuits" meeting and were eventually thanked for saving the aircraft. The final words come from Archer's report:

"I feel constrained to add that both Peter Dawes and I feel we owe our lives in all probability to the skill of Captain Vetch in recovering from a very nasty situation."

PHOTOGRAPHS BY THE AUTHOR

OFF THE BEATEN TRACK

Ever turned a corner to find something unexpected? The Aviation Historian's *intrepid aeronautical explorer* **PETER DAVISON** *investigates the stories behind the oddities that turn up in the most unusual places . . .*

BOAT OR AEROPLANE? Both. And neither. Designed and developed in the Soviet Union, an *Ekranoplan* ("Screenglider") is a wing-in-ground-effect (WIG) machine that flies low, buoyed by a self-generated cushion of air, and a form of hybrid transport that has long fascinated the West.

This example, *Orlyonok* (Eaglet) S-26, was the last of its type to fly in 1993, and is one of four transport/assault vehicles developed by Soviet Ekranoplan pioneer Rostislav Yevgenyevich Alekseyev of the Central Hydrofoil Design Bureau in the early 1970s. Built in 1980, S-26 has been displayed on the bank of the Volga River as part of the memorial complex of the History of the Navy at Tushino in Moscow since 2006.

Two Kuznetsov NK-8-4K turbofans, producing 23,155lb (10,503kg)-thrust each, were buried in the forward fuselage and a side-hinged nose gave access to the capacious interior. Protection was provided by two 12·7mm machine guns in a dorsal turret. Additional cruising power was provided by a single Kuznetsov NK-12MK turboprop engine, as fitted to the Tupolev Tu-95 *Bear*, mounted at the fin/tailplane junction, giving a top speed of around 250 m.p.h. (400km/h) and an operational range of some 935 miles (1,500km).

ABOVE ***Ekranoplan Orlyonok S-26 carries the Russian Navy flag on its fin and is on display mounted on plinths at the Russian Navy Maritime Complex in Moscow. To get a bird's-eye view of the impressive machine on Google Earth, enter the co-ordinates 55°51'05.8"N, 37°27'22.1"E into the "Search" box.***

PETER LEWIS

Coming up in future issues:

Hunter Redefined *Peter Lewis takes an in-depth look at Switzerland's "Hunter 80" programme, in which the venerable Hawker fighter became a formidable ground-attacker*

The "Golden Age" of Travel? *Imperial Airways' C-Class flying-boats were regarded as the height of luxury — but were they? Ralph Pegram takes a closer look at the reality*

The Birth of Global Reconnaissance *Bill Cahill traces the history of Boeing's mighty B-29 as a photo-reconnaissance platform in the early days of the Cold War*

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